

# **Fisheries Specialist Report**

## **South Fork Stillaguamish Vegetation Project**

**Mt. Baker-Snoqualmie National Forest**  
**Darrington Ranger District**  
**Jeremy Gilman**  
**May 23, 2017**

### **1. Applicable Laws, Regulations, and Policies**

- Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan (Forest Plan, as amended).
- Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl, including the Aquatic Conservation Strategy.
- The National Forest Management Act of 1976 mandates...“the environmental protection to ensure timber harvesting will occur only where water quality and fish habitat are adequately protected from serious detriment; ensure clear-cutting and other harvesting will occur only where it may be done in a manner consistent with the protection of soil, watersheds, fish, wildlife, recreation, aesthetic resources and regeneration of the timber resource.”
- Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 et seq.) and its implementing regulations (50 CFR Part 402). Section 7(a)(2) requires federal agencies to review actions authorized, funded, or carried out by them, to ensure such actions do not jeopardize the continued existence of federally listed species, or result in the destruction or adverse modification of designated critical habitat. The Forest Service consults with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) if projects may affect listed species or critical habitat.
- Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.), as amended by the Sustainable Fisheries Act of 1996, and its implementing regulations (50 CFR Part 600). The Magnuson-Stevens Fishery Conservation and Management Act as amended by the Sustainable Fisheries Act of 1996, requires Federal action agencies to consult with the Secretary of Commerce (NMFS) regarding certain actions. Consultation is required for any action or proposed action authorized, funded, or undertaken by the agency that may adversely affect essential fish habitat (EFH) for species managed in Federal Fishery Management Plans. For this project, the Pacific Coast Salmon Plan manages for Chinook, coho, and pink salmon. EFH regulations, 50 CFR section 600.920(a)(1), enable Federal agencies to use existing consultation and environmental review procedures to satisfy EFH consultation requirements.
- Forest Service Manual 2672.4 states: A biological evaluation must be completed for sensitive species for all Forest Service planned, funded, executed, or permitted programs and activities.

### **2. Relevant Standards and Guidelines**

#### 1990 Mt. Baker – Snoqualmie National Forest Plan:

- Maintain the bank, floodplain, and shore stability of all wetlands, streams, lakes, and other bodies of water. Implicit in this standard are actions to prevent all forms of accelerated soil erosion and soil compaction, and the retention of the live root mat to the maximum practicable extent. (p. 4-119)
- Large woody material needed to meet the desired future condition shall be maintained and managed to: (1) maintain water quality in streamside management units of all streams at existing levels, and (2) maintain fish habitat at existing levels. (p. 4-119)
- Maintain in-channel and streambank stability maintained for upper and lower channels in the Forest watersheds in order to provide stable, high-quality in streamside management units of all streams at existing levels, and (2) maintain fish habitat at existing levels. (p. 4-119)
- Maintain pool conditions in both upper and lower channels in the Forest watersheds to: (1) provide high quality habitat for salmon and trout, and (2) provide in-stream flow regulation. (p. 4-119)
- Along perennial streams and fish bearing intermittent streams, vegetation should be maintained to provide cover and/or root strength so as to maintain streambank stability and fish habitat capability at existing levels.
- The Forest shall inventory and map riparian areas during project design and enter information and data into Forest-wide database. (p. 4-120)
- Before project decisions are made, consult with Federal, State, other agencies, groups, and individuals concerned with the management of T&E and sensitive species. In the design of projects for implementation where such species, areas, or habitats are known to occur, insure that appropriate action is taken to protect these species, areas, and habitats. (p. 4-127)

## Standards and Guidelines

#### 1994 Northwest Forest Plan ROD:

As a general rule, standards and guidelines for Riparian Reserves prohibit or regulate activities in Riparian Reserves that retard or prevent attainment of the Aquatic Conservation Strategy objectives. Watershed analysis and appropriate NEPA compliance is required to change Riparian Reserve boundaries in all watersheds.

The identifiers such as TM-1, below, refer to the specific Standard and Guideline in the 1994 Northwest Forest Plan ROD:

### Timber Management

TM-1. Prohibit timber harvest, including fuelwood cutting, in Riparian Reserves, except as described below. Riparian Reserve acres shall not be included in calculations of the timber base.

- a. Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuelwood cutting if required to attain Aquatic Conservation Strategy objectives.

- b. Salvage trees only when watershed analysis determines that present and future coarse woody debris needs are met and other Aquatic Conservation Strategy objectives are not adversely affected.
- c. Apply silvicultural practices for Riparian Reserves to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain Aquatic Conservation Strategy objectives.

## **Roads Management**

RF-4. New culverts, bridges and other stream crossings shall be constructed, and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.

RF-5. Minimize sediment delivery to streams from roads. Outsloping of the roadway surface is preferred, except in cases where outsloping would increase sediment delivery to streams or where outsloping is unfeasible or unsafe. Route road drainage away from potentially unstable channels, fills, and hillslopes.

RF-6. Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.

## **Fire/Fuels Management**

FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet Aquatic Conservation Strategy objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuels management activities could be damaging to long-term ecosystem function.

## **General Riparian Area Management**

RA-2 Fell trees in Riparian Reserves when they pose a safety risk. Keep felled trees on-site when needed to meet coarse woody debris objectives.

RA-4. Locate water drafting sites to minimize adverse effects on stream channel stability, sedimentation, and in-stream flows needed to maintain riparian resources, channel conditions, and fish habitat.

## **3. Other Programmatic Direction**

## ***Memorandum of Understanding with Washington Department of Fish and Wildlife***

An existing Memorandum of Understanding (MOU) between USDA Forest Service and Washington Department of Fish and Wildlife for Hydraulic Permits was signed in 2012 and is in effect until February 3, 2018. This MOU lists provisions under which the Forest Service may complete projects affecting waters of the State without getting a separate written hydraulic permit.

### **4. Definitions of Technical Terms**

**Anadromous**—migrating from the sea to freshwater to spawn

**Critical Habitat** (for threatened or endangered species; from the Endangered Species Act, p. 2)—(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of Section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation of the species. (The USFWS and the NMFS formally designate what is “critical habitat” for their respective species. Critical habitat includes the stream channels with a lateral extent defined by the ordinary high-water line [33 CFR 319.11].)

**Essential Fish Habitat**—those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity

**Redd**—nest made in gravel, consisting of a depression hydraulically dug by a fish for egg deposition and then filled

**Stock** (from WDF et al. 1992)—the fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.

**Unknown** (stock status; from WDF et al. 1992)—description applied to stocks where there is insufficient information to identify stock origin or stock status with confidence.

### **5. Management Requirements and Mitigation Measures**

The following apply to the proposed action alternative:

Table 1. Mitigation Measures and Project Design Criteria

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
Botany			

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
B1 - If any previously undiscovered Threatened, Endangered, or Sensitive (TES) or Survey and Manage (S&M) plants are discovered, before or during project implementation, halt work until a USFS botanist is consulted and necessary mitigation measures are enacted.	Prevent impacts to TES and Survey & Manage plants	HIGH  (Logic)	Forest Plan p. 4-127, USDA Forest Service 1990.
B2 - Treat known infestations of invasive plants before ground disturbance begins.	Prevent the spread of invasive plants	HIGH  (USDA Forest Service 2005a)	Best Management Practices, USDA FS1999  USDA FS 2005a S&C #16
B3 - For actions conducted or authorized by written permit by the Forest Service that will operate outside the limits of the road prism, require the cleaning of all heavy equipment prior to entering NFS lands.	Prevent introduction of weeds into the MBSNF	MODERATE  (USDA Forest Service 2005a)	2005 Region 6 Record Decision for Preventing and Managing Invasive Plants, Standard 2
B4 -Suppliers must provide annual documentation indicating that the following products have been examined by a qualified inspector and deemed free of State listed noxious weeds:  Straw, wood straw or other Mulch <sup>1</sup>  Gravel, Rock, or other fill  Seeds (according to AOSA standards)	Prevent introduction of weeds	MODERATE  (USDA Forest Service 2005a)	USDA FS 2005a S&C #3 & 7  Forest Plan Best Management Practices, USDA FS 1999
B5 –If weeds are present in the project area, all equipment and gear must be cleaned before leaving the project area to avoid spreading the infestation further.	Prevent weed spread	MODERATE (logic).	Best Management Practices, USDA Forest Service 1999

---

<sup>1</sup> Weed free straw for erosion control must be certified by WA State via the WWHAM program:  
<http://agr.wa.gov/PlantsInsects/WWHAM/WWHAM.aspx>

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
B6 - If weeds are present in the project area, work from relatively weed-free areas into the infested area rather than vice versa.	Prevent weed spread	MODERATE (logic).	Best Management Practices, USDA Forest Service 1999
B7 - Revegetate designated areas of bare soil exposed by project activities. Native plant materials are the first choice in revegetation where timely natural regeneration of the native plant community is not likely to occur. If native plant materials are not available, use the appropriate MBS non-native seed mix (per Potash and Aubry 1997, as amended).	Prevent erosion, prevent introduction and spread of weeds, maintain, and restore habitat	HIGH  (USDA Forest Service 2005a)	Forest Plan  S&G #13, USDA Forest Service 2005a, Best Management Practices, USDA Forest Service 1999, ACS S&G # 8 & 9, USDA Forest Service & USDI Bureau of Land Management 1994.
B8-For Washington State Class A and B designate noxious weeds <sup>2</sup> : treat with the most effective method; after treatment has taken effect, cover the infestation with geotextile fabric to avoid spreading seed or roots remaining in the soil. Avoid disturbance to area. If disturbance cannot be avoided, treat infestation first, then wash equipment after working in the infested area before moving into an uninfested area.	Eradicate known infestations and prevent weed spread	High	WAC Chapter 16-750 RCW 17.10
<b>Heritage</b>			
H1 - If a previously unidentified cultural resource(s) is discovered during project implementation, or if an identified resource(s) is affected in an unanticipated way, the activity shall be stopped in the area of the find and a reasonable effort to secure and protect the resource(s) be made. The Heritage Specialist shall be notified and the Forest would fulfill its responsibilities in accordance with the Programmatic Agreement and other applicable regulations.	Protect heritage resources	MODERATE (MBS Forest experience)	Pursuant to Stipulation III.C of the Programmatic Agreement. USDA 1998,99, Archaeology Protection

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
H2 - If Indian human remains or specified cultural items are discovered, stop work, and secure the find. Make appropriate notification, and adhere to regulatory process.	Protect American Indian burials and cultural items	UNKNOWN MODERATE TO HIGH  (Literature)	43 CFR 10
<b>Lands</b>			
L-1 - Notify land owners in advance of any temporary road closures that would affect their access, and allow either alternate access or permitted access through any temporary closure where needed (road signage)	Recognize rights of access held by holders of valid mining claims to their private land within and adjacent to project area	HIGH  (Logic)	FSM 7715.75; Timber Sale Contract clause
L-2 - Maintain project boundaries adjacent to private lands to ensure that no project activities will intrude upon private lands.	Protect quarry and surroundings from invasive weeds and other unplanned impacts	MODERATE  (USDA  (Logic)	36 CFR 228 Regulations; 2005 Region 6 Record of Decision for Prevention and Managing Invasive Plants, Standard 2
<b>Minerals</b>			
M1 - Notify existing mining claimants in advance of any temporary road closures, and allow either alternate access, or permitted access through any temporary closure to their individual mining claims. (signage)	Recognize rights of access held by holders of valid mining claims to their claims.	HIGH  (Logic)	36 CFR 228 Regulations;
LM2 - Require each quarry entry to have an accompanying operating plan, which would require all equipment entering the quarry(s) to be clean and weed seed free.	Protect quarry and surroundings from invasive weeds and other unplanned impacts	MODERATE  (USDA Forest Service 2005a)	36 CFR 228 Regulations; 2005 Region 6 Record of Decision for Prevention and Managing Invasive Plants, Standard 2
<b>Soil, Water, and Fisheries</b>			

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF1 – 100 foot slope distance minimum no-cut buffer along the South Fork Stillaguamish River. Buffer is to be measured from outer edge of riverbank from the top of the inner gorge, whichever is greater. No cutting will occur within the Channel Migration Zone of the South Fork Stillaguamish River.</p> <p>No-cut buffer will be determined during sale layout, by pre-sale and/or aquatics staff.</p>	<p>Retain riparian vegetation to maintain shade for stream temperature, large wood recruitment, slope stability, and minimize soil erosion. Provide protection for aquatic and riparian dependent species.</p>	<p>HIGH</p> <p>(Literature and Forest Experience)</p>	<p>1994 ROD ACSOs p. 11&amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>WDOE 2004 Stillaguamish River Basin TMDL</p> <p>Anderson and Poage 2014, Benda et al. 2011, Groom et al. 2011a, Rashin et al. 2006, Anderson 2007</p>
<p>SWF2 – 100 foot slope distance minimum no-cut buffer along all ESA listed fish-bearing intermittent and perennial streams. Buffer is to be measured from outer edge of streambank, 100 yr floodplain, or from the top of the inner gorge, whichever is greater.</p> <p>No-cut buffer will be determined during sale layout by pre-sale and/or aquatics staff.</p>	<p>Retain riparian vegetation to maintain shade for stream temperature, large wood recruitment, slope stability, and minimize soil erosion. Provide protection for aquatic and riparian dependent species.</p>	<p>HIGH</p> <p>(Literature and Forest Experience)</p>	<p>1994 ROD ACSOs p. 11&amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>Rashin et al. 2006</p> <p>Anderson and Poage 2014</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF3 – 100 foot slope distance minimum no-cut buffer along all non-ESA listed fish-bearing intermittent and perennial streams. Buffer is to be measured from outer edge of streambank, 100-year floodplain, or from the top of the inner gorge, whichever is greater.</p> <p>No-cut buffer will be determined by pre-sale and/or aquatics staff.</p>	<p>Retain riparian vegetation to maintain shade for stream temperature, large wood recruitment, slope stability, and minimize soil erosion. Provide protection for aquatic and riparian dependent species</p>	<p>HIGH</p> <p>(Literature and Forest Experience)</p>	<p>1994 ROD ACSOs p. 11&amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>USDA FS &amp; USDI B 2010</p> <p>Rashin et al. 2006</p> <p>McDade et al. 1990</p> <p>Anderson and Poage 2014</p>
<p>SWF4 – 30 foot slope distance minimum no-cut buffer along all non-fish bearing perennial streams. Buffer is to be measured from outer edge of streambank, 100-year floodplain, or from the top of the inner gorge, whichever is greater.</p> <p>No-cut buffer will be determined by pre-sale and/or aquatics staff.</p>	<p>Retain riparian vegetation to provide shade to maintain stream temperatures and slope stability, minimize soil erosion, and protect riparian vegetation. Provide protection of aquatic and riparian dependent species.</p>	<p>MODERATE to HIGH</p> <p>(Literature)</p>	<p>1994 ROD ACSOs p. 11&amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>USDA FS &amp; USDI B 2010</p> <p>Rashin et al. 2006</p> <p>Benda et al. 2016Grooc et al. 2011a</p> <p>Anderson 2007</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF5 – 15 foot slope distance minimum no-cut buffer along all non-fish bearing intermittent streams. Buffer is to be measured from outer edge of streambank, 100-year floodplain, or from the top of the inner gorge, whichever is greater.</p> <p>No-cut buffer will be determined by pre-sale and/or aquatics staff.</p>	<p>Retain riparian vegetation to provide shade to maintain stream temperatures and slope stability, minimize soil erosion, and protect riparian vegetation. Provide protection of aquatic and riparian dependent species.</p>	<p>MODERATE  (Literature )</p>	<p>1994 ROD ACSOs p. 11&amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>USDA FS &amp; USDI BLM 2010</p> <p>Rashin et al. 2006, Benda et al. 2016, Anderson and Poage 2014, Groom et al. 2011a, Anderson 2007</p>
<p>SW5 (cont.) In addition to the 15-foot no-cut buffer on intermittent streams no ground-based equipment would be allowed within 25 feet of any waterbody or top of inner gorge, whichever is greater. Trees cut within this boundary would be felled and dragged out of this 25 feet buffer before being loaded on ground-based equipment.</p> <p>No-cut buffer will be determined by pre-sale and/or aquatics staff.</p>	<p>Maintain slope stability, minimize soil erosion, and protect aquatic and riparian dependent species.</p>	<p>HIGH  (Literature and Forest Experience)</p>	<p>1994 ROD ACSOs p. 11&amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>USDA FS &amp; USDI BLM 2010</p> <p>Rashin et al. 2006</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF6 – 30 foot slope distance minimum no-cut buffer around ponds, wetlands, seeps and springs. Buffer is to be measured from the edge of the water, the outer edge of the riparian vegetation or the extent of seasonally saturated soil, whichever is greater.</p> <p>No-cut buffer will be determined by pre-sale and/or aquatics staff.</p>	<p>Minimize soil disturbance, protect riparian vegetation, and provide protection of aquatic and riparian dependent species.</p> <p>Provide a buffer of no disturbance around waterbody for movement by amphibians to and from breeding sites.</p>	<p>HIGH</p> <p>(Literature and Forest Experience)</p>	<p>1994 ROD ACSO p. 11 &amp; RR p. C-30</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>Rashin et al. 2006</p>
<p>SWF7 – 30-foot slope distance minimum no-cut buffer around unstable and potentially unstable areas. Buffer is to be measured upslope from major slope breaks that define a headwall, inner gorge or other potential unstable areas.</p> <p>Landforms with slope stability concerns are identified in the Soils Specialist Report.</p> <p>No-cut buffer will be identified by pre-sale and/or aquatics staff with approval from FS Geologist or Soil Scientist.</p>	<p>Prevent management related slope instability within headwall, failure of inner gorges, or unstable areas.</p>	<p>HIGH</p> <p>(Literature and Forest Experience)</p>	<p>1994 ROD ACSOs p. 11&amp; S&amp;Gs p. C-31</p> <p>USDA FS 2012 FS National Core BMPs - Veg. #1-3</p> <p>WDNR et al. 1997</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF9 – All yarding and haul activities will be scheduled to a Normal Operating Season (NOS), defined as June 1 to October 15.</p> <p>During periods outside the NOS, yarding and haul operations may proceed with both: (1) notification of decision maker and aquatic specialists and (2) monitoring of weather and conditions to evaluate if wet weather logging operations meet project design elements and Management Requirements and Mitigation Measures.</p> <p>Any pre-approved hauling activities occurring outside of the NOS defined as June 1 to October 15 will require monitoring of conditions as follows:</p> <p>Implementation and effectiveness monitoring of BMPs will be part of the wet weather haul agreement.</p> <p>Potentially damaging project activities will be curtailed and corrective action taken when situations develop such as: ponding, rutting, rilling, scour or sediment transport and deposition downstream of cross drains, Actions will be taken when adverse conditions are encountered on adjacent system roads, temporary roads, skid trails, landings, haul routes, stream crossings, riparian reserves or within harvest units where ground disturbance has occurred.</p>	<p>Minimize short- and long-term soil, hydrologic and water quality impacts at the project level and off-site.</p>	<p>MODERATE</p> <p>(Avoid activity when impact would occur)</p>	<p>USDA FS Region 6 Soil Quality Standards</p> <p>FSM 2520,R-6 Supplement No 2500.1</p> <p>1994 ROD ACSOs p. B11 #2, #8, &amp; #9; RRs pp. C31-32 FW-1 &amp; p. C-37</p> <p>USDA FS 2012 National Core BMPs – Veg. #1 #4</p>
<p>SWF10 – Directionally fall trees away from no-cut riparian buffers where possible to protect riparian vegetation and soils from damage.</p> <p>Trees inadvertently felled into no-cut buffers may be removed with one-end suspension. Portions of these trees that reside within 30 feet of the aquatic resource will be left in place.</p> <p>.</p>	<p>Minimize short- and long-term soil, hydrologic and limit water quality impacts.</p> <p>Meet FS region 6 Soil Quality standards</p>	<p>HIGH(Avoidance)</p>	<p>USDA FS Region 6 Soil Quality Standards (FSM R6 2521.03)</p> <p>USDA FS 2012 National Core BMPs – Veg. #1 #5</p> <p>1994 ROD p. B-11 #2 #8, #9; pp. C31-32; FW-1 &amp; p. C-37</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
SWF11 – Avoid harvest on areas that have average sideslopes greater than 80 percent. Some trees may be cut on slopes steeper than 80 percent for occasional skyline corridors in order to access areas of a unit less than 80 percent.	Minimize soil erosion, maintain slope stability, and damage to felled and residual trees.  Meet FS Region 6 Soil Quality Standards	MODERATE  (Limits activity where impact would occur)	USDA FS Region 6 Soil Quality Standards (FS R6 2521.03)  USDA FS 2012 National Core BMPs – Veg. #1 & #5  1994 ROD ACSOs p. 11 #2, #8, & #9; RR p. C31-32 FW-1 & p. C-  USDA MBS 1990
SWF12 – If it is necessary for equipment to travel away from approved corridors or temporary roads, the machines will operate on a slash mat of limbs and tops that is deposited directly in front of the machine. This mat will be as thick and continuous as practicable. Activities will be planned to make as few trips as possible.	Minimize short- and long-term soil, hydrologic and water quality impacts.	MODERATE to HIGH  (BMP, NFS Experience)	
SWF13 – If mobile or other anchors are needed outside of cutting units that may result in impacts to soils or adjacent forest stands, the aquatics specialist will be notified.	Minimize impacts to soils and vegetation outside of harvest units	MODERATE  (Limits activity where impact would occur)	USDA FS 2012 National Core BMPs – Veg. #1 & #5

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF14 – When constructing landings or new turnarounds:</p> <p>No unanalyzed landings or turnarounds will be constructed outside of EA stand boundaries without notification of the IDT.</p> <p>Make all attempts to locate new landings or turnarounds a minimum 150-foot slope distance from rivers, streams, ponds, seeps, wetlands, and wet areas. If location outside of the 150-foot slope distance is not possible, then landings or turnarounds shall be located outside of the applied no-thin buffer for that stream type. Landings needed within the no-thin buffer of fish-bearing streams will require approval from aquatic specialist prior to implementation.</p> <p>If landings or turnarounds must be located within 150-foot slope distance, they will be placed on existing roadways or on existing landings that require only minimum reconstruction (e.g., clearing vegetation, sloping for drainage, or surfacing for erosion control purposes) to be made suitable for use.</p> <p>Any new landing or turnaround construction areas (or portions thereof), which are not located on existing roadways or cleared, compacted areas, will be treated with one or more of the following: decompaction and mulching with certified weed-free straw, woodstraw, or slash after use, and/or seeding with erosion control seed mix.</p>	<p>Minimize soil disturbance, protect riparian vegetation, protect aquatic and riparian habitat, and minimize impacts to other resources (e.g. heritage or wildlife).</p>	<p>HIGH</p> <p>(Avoidance)</p>	<p>USDA FS 1990</p> <p>USDA FS &amp; USDI B 1994</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF15 – Maintenance and erosion control on landings, disturbed skyline corridors, skid roads, and temporary and permanent roads will be completed prior to the onset of expected seasonal periods of precipitation or runoff, and kept current during and outside of NOS.</p> <p>As conditions require, sediment filters (straw bales, slash filter windrow, and/or sediment fence) will be placed in ditchlines along the haul route or in areas where ground is disturbed and sediment has the potential for delivery to streams (i.e. stream crossing fills, adjacent to downhill skyline units). Sediment filters will be maintained and adjusted as needed. Removal of sediment filters will be done when site conditions are dry, and captured sediment will be relocated locally to stable locations away from stream courses.</p>	<p>Minimize short- and long-term soil, hydrologic and water quality impacts.</p>	<p>MODERATE to HIGH (BMP, NFS Experience)</p>	<p>USDA FS 2012 National Core BMPs – Veg. #1 &amp; #5 T-6 and T-13  standard timber sale contract clause BT6.6 Erosion Prevention and Control</p>
<p>SWF16 – Areas of gouging or soil displacement on steep slopes resulting from yarding systems will be treated to prevent rill and gully erosion and possible sediment delivery to stream courses. Erosion control treatments may include, but are not limited to: repositioning displaced soil to re-contour disturbed sites; creating small ditches or diversions to redirect surface water movement; installation of coir logs along slope contours; and scattering slash material to create flow disruption and surface soil stability. These measures will be in place prior to expected seasonal periods of precipitation or runoff, and kept current during and outside of NOS.</p>	<p>Minimize short- and long-term soil, hydrologic and water quality impacts.</p>	<p>MODERATE to HIGH (BMP, NFS Experience)</p>	<p>BMPs T-6 and T-13</p>
<p>SWF17 – For skyline systems:</p> <p>Yarding with full suspension would be allowed across or over potentially unstable slopes, streams, wetlands, wet areas, and other no-cut buffers with BMPs. Corridors will, whenever possible, be no more than 15 feet wide. All corridors will generally be approximately 120 feet apart (average)</p>	<p>Minimize short- and long-term soil, hydrologic and water quality impacts.</p>	<p>HIGH (Avoidance)</p>	<p>USDA FS Region 6 Silvicultural Quality Standards (FS R6 2521.03)  USDA FS 2012 National Core BMPs – Veg. #1 &amp; #5  1994 ROD p. B-11 #1, #8, &amp; #9; pp. C31-32 FW-1 &amp; p. C-37</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF18 – Traditional ground-based log transport equipment is restricted to sustained slopes that are no greater than 35 percent. Non-yarding ground-based equipment (such as a self-leveling feller-buncher) is restricted to sustained slopes less than 50%.</p> <p>Tethered ground-based equipment is restricted to sustained slopes that are no greater than 80 percent, with monitoring to determine if operations are meeting thinning objectives and standards and guidelines to minimized impacts to other resources</p> <p>Stands proposed for tethered based harvest and yarding will have approved monitoring criteria identified prior to operations.</p> <p>Stands proposed for tethered based harvest and yarding will be approved by the Timber Sale Administrator (in consultation with the ID team) prior to operations.</p>	<p>Minimize extent and degree of soil in a detrimental condition and meet desired stand conditions.</p> <p>Monitor amount of soil disturbance created by tethered based operations.</p> <p>Compare soil disturbance and impacts to aquatic resources from tethered based operations to standard harvest and yarding methods.</p>	<p>MODERATE  (Limits activity where impact would occur)</p> <p>UNKNOWN (tethered equip)</p> <p>Monitoring will allow data to be collected and analyzed for evaluation of equipment operations and incorporation into future planning</p>	<p>USDA FS Region 6 and MBSNF Soil Quality Standards (FSM 2520,R-6 Supplement No 2500.98-1);</p> <p>USDA FS 2012 National Core BMPs – Veg. 1</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>SWF19 – For ground-based yarding:</p> <p>Skid trails must be approved by the Timber Sale Administrator prior to felling and construction operations.</p> <p>Old skid trails will be used wherever possible, as long as they avoid wet areas and will prevent sediment delivery to streams.</p> <p>Skid trails will generally be no closer than 100 feet apart, center-to-center, and be only as wide as necessary for the equipment to travel (less than 15 feet wherever possible). Erosion control devices such as waterbars and/or slash will be used as necessary on sloped skid roads.</p> <p>Ground-based skidding and yarding operations shall be conducted with one-end suspension to minimize soil erosion.</p> <p>Wherever possible, skid trails will be located a minimum of 25 feet away from riparian no-cut buffers.</p> <p>To travel off approved skid trails, equipment (i.e. harvester, feller/buncher, shovel) will operate on a slash mat whenever possible. The slash mat should consist of limbs and tops deposited directly in front of the machine. The mat will be thick and continuous as practicable. Activities will be planned to make as few trips as possible.</p>	<p>Prevent management-related unacceptable degree and extent of surface erosion and other long-term detrimental soil conditions.</p>	<p>MODERATE</p> <p>(Limits activity where impact would occur)</p>	<p>USDA FS 2012 National Core BMPs – Veg. #1 &amp; #5</p> <p>BMP #T-11</p>
<p>SWF20 – Schedule road reconstruction activities (includes rock additions) during the NOS.</p> <p>Additional spot rocking may be required to keep roads in acceptable condition during wet season haul as per the wet weather haul agreement.</p> <p>.</p>	<p>Avoid or minimize direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely to occur.</p>	<p>MODERATE</p> <p>(Avoid activity when impact would occur)</p>	<p>USDA FS 2012 FS National Core BMPs – Roads #5</p> <p>USDA FS 2009 T-5, R-3, R-7</p>

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
SWF21 – Comply with all requirements of the Memorandum of Understanding (MOU) between the WDFW and USFS for Hydraulic Permit Approval (2012-2018).	Ensuring compliance with State regulations that protect aquatic and related resources	MODERATE	USFS & WDFW MOU 2012-2018
SWF22 – For road closure and decommissioning activities, comply with and adhere to all requirements of Regional General Permit #8 (RGP-8) (2011) authorized by the Seattle District of the US Army Corps of Engineers, including all special conditions, general conditions, and design criteria of the authorized activities.	Compliance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899.	MODERATE	RGP-8 2011
SWF23 – Disturbance of vegetation shall be limited to the minimum amount necessary to accomplish road closure, obliteration, and decommission work.	Protect and minimize Riparian Reserve impacts	MODERATE (Consultation, BMP, MBS Forest Experience)	BMP, ACS, 1990 Forest Plan, p. 4-126, 119, & RGP-8 (2011)
SWF24 – Ground-disturbing activities within channels, and along the banks of fish-bearing streams or streams located within ¼ mile of fish-bearing streams shall be performed during approved instream work window (August 1 <sup>st</sup> -August 15 <sup>th</sup> , or as approved by WDFW and USFS Fisheries Biologists).	Avoid or minimize negative impacts to fish	HIGH (Consultation with USFWS and NMFS regulatory agencies concur this is effective)	USFS & WDFW MOU 2012-18

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
SWF25 – When reconstructing roads, install stream-crossing structures at the location where water flows into roadbed. All installed culverts or crossing features should maintain flow down primary, natural pathway of flow and not redirect flow into a ditch, pond, or another channel. Exceptions may be approved by the Aquatics Specialist.	Minimize disruption of natural hydrologic flow paths, including surface and subsurface flow. Ensuring compliance with State regulations that protect aquatic and related resources.	MODERATE to HIGH  (BMP, NFS Experience)	USFS & WDFW MO 2012-18  1994 ROD ACSOs p. 11 & RR pp. C -32 & (RF-3a & RF-4)  USDA FS 2012 FS National Core BMPs Roads #7
SWF26 – Perennial stream crossings should be reconstructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure. This may involve cleanout of plugged culvert inlets, lowering of road fill at the culvert crossing, and/or construction of a drivable dip downgrade of the crossing.	Prevent diversion of streamflow out of the channel and down the road in the event of crossing failure. Such failures can result debris flows or mass wasting events due to fillslope or culvert failures downgrade of crossing.	MODERATE to HIGH  (BMP, NFS Experience)	1994 ROD ACSOs p. 11 & RR pp. C -32 & (RF-3a & RF-4)  USDA FS 2012 FS National Core BMPs Roads #7  USDA FS 1997
SWF28 – New temporary roads, including those identified and shown on EA alternative maps will be located and designed to minimize disruption to hydrologic flows by:  Minimizing clearing limits (generally no more than 16 feet on level ground, 20 feet for curves, slightly more for steeper hillslopes);  Minimizing excavation of cutslopes and fillslopes; and  Routing drainage away from potentially unstable hillslopes, sidecast, and channels.	Minimize disruption of natural hydrologic flow paths, including surface and subsurface flow.  Protect and minimize impacts to riparian areas, habitats, and dependent species, including amphibians.	MODERATE  (BMP, NFS Experience)	1994 ROD ACSOs p. 11 & RR pp. C -32 & (RF-2e, 2g & RF-3b)  USDA FS 2012 FS National Core BMPs Roads #2 & 7

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
SWF29 – If temporary roads, other than those identified and shown on EA alternative maps, are proposed for construction they would be located within EA stand boundaries and avoid sensitive sites such as shallow soils, unstable landforms; wetlands and minimize disruption of natural hydrologic flow paths, including surface and subsurface flow. Upon additions or changes to the road system, consult the ID Team to ensure changes are within the effects analyzed.	Minimize disruption of natural hydrologic flow paths, including surface and subsurface flow.  Protect and minimize impacts to riparian areas, habitats, and dependent species, including amphibians.	HIGH  (Avoidance)	1994 ROD ACSOs p. 11 & RR pp. C -32 & (RF-2e, 2g & RF-3b)  USDA FS 2012 FS National Core BMPs Roads #2 & 7
SWF30 – Any timber sale temporary access roads identified to remain in place over the winter (into a second year of operation) shall use drainage features (culverts and/or water bars) that would accommodate a 100-year flood and associated debris flow, including seeding and mulching of any exposed or disturbed soils.	Prevent erosion and/or mass wasting and road damage	MODERATE  (Relatively new requirement, but based on permanent road requirements)	USDA FS USDI BLM 1994 p. C-30, NWFP ROD RF-4 and RF-5
SWF31 – Design road drainage features to hydrologically disconnect road surface runoff from stream channels and wetland areas. On roads to be closed or decommissioned, cross-drains or water bars will be installed at a maximum spacing of 400 feet where road grade exceeds 2 percent or modified with approval from an Aquatics Specialist.	Protect stream channel from water quantity and quality impacts	MODERATE to HIGH (BMP, NFS Experience)	BMP, Copstead et al, (1998), & RGP-8 (2001)
SWF32 – Existing unclassified and previously decommissioned roads will be reconstructed in a way that adequately addresses road drainage, cutslope and fillslope instability, and potential water diversions. Sidecasting of loose material is prohibited within 150 feet of aquatic resources.	Protect and minimize Riparian Reserve impacts. Minimize disruption of natural hydrologic flow paths, including surface and subsurface flow.	MODERATE to HIGH (BMP, NFS Experience)	USDA FS 2012 FS National Core BMPs Roads #2 & 7

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
<p>SWF33 – Roadbeds of decommissioned and obliterated roads would be reclaimed to resist erosion, improve subsurface hydrology, improve regrowth, and deter motorized traffic.</p> <p>Reclamation may include: (1) improving the infiltration by decompaction to a depth of 18 inches, and/or outsloping towards the natural contour; and (2) stabilizing the surface by either applying mulch or by distributing slash across 70 percent of the disturbed ground surface, whichever is appropriate, and seeded with appropriate mix as described in mitigation B7.</p>	Restore eco-hydraulic function of soils and soil productivity	MODERATE to HIGH (BMP, NFS Experience)	USDA FS 2012 FS National Core BMPs Road-5 & 6
<p>SWF34 – During road obliteration or decommission activities, remove all fill material and man-made structures from stream channels. After removal, stream channel shall match upstream and downstream channel dimensions, channel roughness, bank shape, natural floodplain contours, and natural adjacent hillslope.</p> <p>Notify Aquatic Specialist of any changes in final specifications for stream crossing removal, outsloping and road-decommissioning designs.</p>	Restore eco-hydraulic function of channel, valley bottom and riparian areas	MODERATE to HIGH (NFS Experience)	BMP, ACS, 1990 Forest Plan, p. 4-126, 119, RGP-8 (2011), & WDFW MOU (2012-2018)
SWF35 – Dust abatement for use on haul roads will be limited to the use of clean water or Lignin.	Protect water quality. Prevent chemically laden water from entering waterways.	HIGH	BMP, ACS
SWF36 – Trash and removed culverts shall be removed from National Forest System (NFS) lands and disposed of at an appropriate disposal area.	Keep forest clean and free of trash.	HIGH	BMP

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
SWF37 – Heavy machinery and project service vehicles shall be free of leaks. Operators shall check heavy machinery for leaks prior to commencement of daily work. Repairs will be conducted before commencement of or continuing work.	Prevent and minimize potential effects to water quality	HIGH  (NFS Experience)	BMP, FP-03, ACS, 1990 Forest Plan p. 4-126, & RGP-8 (2011)
SWF38 – Establish a Spill Prevention Control and Containment Plan (SPCCP) when total oil products storage exceeds 1,320 gallons in containers of 55 gallons or greater. Maintain a spill remediation kit onsite for any fuel stored on NFS lands in association with this project. Fuels stored on NFS lands shall be 100 feet from aquatic resources.	Prevent and minimize potential effects to water quality	HIGH (Standard for Construction )	BMP, FP-03, ACS, & 1990 Forest Plan p. 4-126  40 CFR 112 Standard provision in contract
<b>Wildlife</b>			
W1 –Trees greater than 20 inches DBH will not be cut. Any trees greater than 20 inches DBH that are required to be cut for safety will remain on site as coarse woody debris. Safety or operational trees within 50 ft. of an open road would be considered for removal to reduce fuel loading and loss of wood to firewood cutters.	To maintain and retain late-successional conditions	HIGH  Contract requirement	LSR plan implementation – exemption to REO let
W2 – Retain existing down woody debris and standing snags that are not deemed a hazard.	Maintain and enhance habitat diversity	MODERATE - LOW Availability within project stands.	Wildlife Forest-wide S&G (p. 4-124)
W3 -- If raptor nest sites are found within the Project area during sale layout or implementation, activities will stop and a Forest Service Wildlife Biologist will be consulted. At the Wildlife Biologist's discretion, protective buffers and/or seasonal operation restrictions may be assigned to the newly located nest sites.	Minimize changes to microhabitat features adjacent existing nest sites & the protection of active nest site	HIGH  Forest Experience	Migratory Bird Act  Wildlife Forest-wide S&G (4-125)

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
<p>W4 –Trees with interlocking branches with trees with suitable nest structure for owl and murrelet nest would be retained (visible suitable cavities or nest structure (platforms 4” at 30 ft.).</p> <p>Presale staff to coordinate with wildlife biologist on dimension from suitable nest trees</p>	Maintain microhabitat conditions around potential nest trees	HIGH  Forest Experience	ESA Section 7 consultation
<p>W5- Any tree <math>\geq 21</math> inch dbh located in adjacent old-growth habitat proposed as a tailtree or anchor will first be field reviewed by a Forest Wildlife Biologist or their representative to determine if the selected tree is a spotted owl or marbled murrelet potential nest tree (PNT). All tailtrees will be retained as future wildlife trees, unless a hazard tree.</p>	Protect occupied nest trees of federally protected species (northern spotted owl and marbled murrelet)	HIGH  Contract requirement	Wildlife Forest-wide S&G (4-124)
<p>W6-The thinning prescription would designate an average of 10 wildlife trees/ac be retained that include dominant trees for future large snags, and marking of deformed green trees to retain for future wildlife trees.</p> <p>Desired wildlife trees/ac can be counted from skips, Riparian Reserve marking, murrelet leave trees, and snags from high stumping of hazard trees (20 ft – reach of ground equipment or 4 ft. height for sawyer on ground) and by leaving green trees around snags of greater than 21 inches.</p>	Snags and green trees would be designated for retention during sale layout to meet standards and guidelines for cavity nesters	HIGH  Contract requirement	Wildlife Forest-wide S&G (4-124)
<p>W7- Dominant trees infested with dwarf mistletoe will be retained in the thinning marking with thinning to occur within mistletoe stands to enhance light for growth.</p>	Maintain and enhance murrelet nest structure and Hairstreak butterfly habitat	HIGH  Contract requirement	Wildlife Forest-wide S&G (4-124)

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
W8 - Heavy equipment and other activities generating noise above ambient levels in historic owl or murrelet use areas, and occurring between April 1 and September 15 would occur between two hours after sunrise to two hours before sunset.	Reduce the potential disruption of marbled murrelet feedings or nesting.	Moderate  90% impacts reduction post-incubation stage; pre-incubation, the, mitigation would be ineffective	ESA Section 7 consultation
W-9 – Slash pile burning would occur during the time period of August 31 to February 28, outside of the early nesting season. In the event that burning activities cannot be accomplished in this work window, the wildlife biologist will be advised and work with fire staff to meet approved conditions for fire control and smoke management.	Reduce the potential disruption of marbled murrelet feedings or nesting	HIGH  Contract requirement	ESA Section 7 consultation
W-10 Use of biodegradable materials in wattles and other erosion control materials, unless removed following utilization.	Reduce impacts to amphibians and other small wildlife species that would get caught in the netting.	High  Contract requirement	Forest Plan – Maintain viable species - Forest plan goal – 4-124
W-11 Seasonal operating (October 31 to June 15th) restrictions would be utilized for operations in the project area that are located adjacent and within designated mountain goat habitat (MA-15).	Protect and manage habitat to maintain or increase mt. goat populations	High	Forest Plan – Maintain viable species - Forest plan goal – 4-124  Administrative Use – Forest plan 4-234
<b><i>Recreation</i></b>			

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>REC1– To facilitate the safe completion of logging-related operations associated with proposed harvest units, and to maintain full public access to highly desired recreation sites, the Heather Lake, Mt. Pilchuck, Sunrise Mine, Boardman Lake, and Walt Bailey/Mallardy Ridge trail/trailheads will remain open to the public from Friday at noon through Sunday and holidays.</p> <p>In addition, potential closure periods will last no more than 3 months during the peak season (May through Sep) and 4 months during non-peak season (Oct thru Apr) when feasible.</p>	<p>Provide for public safety where mixing of uses would increase conflict and risk.</p> <p>Minimize potential for non-operational disruptions with partial closures</p>	<p>HIGH</p> <p>Logic: Partial closures would cause production loss and reduced efficiency, extending the time required to finish work in most harvest stands.</p>	<p>Forest Plan (1994-Amended), Forest-Wilderness S&amp;G's (pg. 4-84 to 4-177) and Matrix/MA 2A&amp;2 S&amp;G's (pg. 4-177)</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>REC2 –Because of a lighter demand/visitation experienced during October through April, up to two recreation sites/access roads including roads used to access high use recreation sites may be closed at any one time during non-peak period to public access. This will better allow completion of logging activities and reopening of sites on or before May 30<sup>th</sup>.</p>	<p>Maintain a significant portion of hiker accessibility and parking capacity within the entire MLSB corridor commensurate with peak season accessibility limitations.</p>	<p>MODERATE – HIGH</p> <p>Logic, Staff Experience</p> <p>In the MLSB recreation corridor, during May-September trails/trail-heads can handle an estimated 200 to 300 daily visitors. Thus, there remains opportunity for displaced recreationists on unaffected trails such as Barlow Pass, Lake 22, Mt. Dickerman etc.</p>	<p>Forest Plan (1994-Amended), Forest-Wilderness S&amp;G's (pg. 4-84 to 4-177) and Matrix/MA 2A&amp;2B S&amp;G's (pg. 4-177)</p>

Mitigation Measure or Project Design Feature	Objective	Effectiveness and Basis	Regulatory or Scientific Basis
<p>REC3 –During the peak season (May through September), only one of the two highest use recreation sites (Heather Lake, Mt. Pilchuck) within the corridor will be allowed to remain closed to the public at any one time during this critical period, unless it is deemed unsafe to perform logging activities while the site is open.</p>	<p>Maintain overall hiker accessibility and parking capacity within the entire MLSB corridor commensurate with peak season accessibility and historic fluctuations in use.</p>	<p>MODERATE-HIGH</p> <p>Logic, MBS Experience: In the MLSB recreation corridor, Mt. Pilchuck and Heather Lake trailheads are two of the highest use sites. Impact to recreation resources is high if both sites are closed for long periods of time.</p>	<p>Forest Plan (1994-Amended), Forest-Wilderness S&amp;G's (pg. 4-84 to 4-177) and Matrix/MA 2A&amp;2B S&amp;G's (pg. 4-177)</p>
<p>REC4– Public access (peak and non-peak recreation season) through or near units being logged to reach both developed and dispersed recreation sites will be provided from Friday noon to Sunday mid-night and on all holidays falling on a weekday.</p>	<p>Provide unrestricted public access to all recreation sites not affected directly by either a special closure related to ongoing logging activities.</p> <p>Provide a public notification plan informing the public of key entry points and potential hazards and likely delays.</p>	<p>MODERATE – HIGH</p> <p>MBS Experience (see REC1)</p>	<p>Forest Plan (1994-Amended), Forest-Wilderness S&amp;G's (pg. 4-84 to 4-177) and Matrix/MA 2A&amp;2B S&amp;G's (pg. 4-177)</p>

<b>Mitigation Measure or Project Design Feature</b>	<b>Objective</b>	<b>Effectiveness and Basis</b>	<b>Regulatory or Scientific Basis</b>
VIS1- The visual impacts of skyline corridors, landings, raw areas and skid roads will be minimized, these areas will be seeded, mulched or revegetated if needed within 1-3 years from project completion.	Meet visual quality objective-Retention or Partial Retention	MODERATE : logic, experience, Handbook guidance	Forest Plan (1994-Amended), Forest-Wilderness S&G's (pg. 4-86 to 4-93), MA2A(pg 4-169-172), Matrix/MA2B (4-172 to 4-175), R6-REC-TP-016-90, FSH 2309.16
VIS2- To minimize the visual impacts stumps will be cut within 12 inches of the forest floor up to 75' (from the top of bank) into the unit along the edge of areas managed for VQO <i>Retention</i> or <i>Partial Retention</i>	Meet visual quality objective-Retention or Partial Retention	High: logic, experience, Handbook guidance	Forest Plan (1994-Amended), Forest-Wilderness S&G's (pg. 4-86 to 4-93), MA2A(pg 4-169-172), Matrix/MA2B (4-172 to 4-175) R6-REC-TP-016-90, FSH 599
VIS3- To minimize the visual impact of temporary roads, skid trails and landings in ground based or cable yarded units, the surface of these features will be decompacted to facilitate natural plant establishment to meet VQO's of Retention and Partial Retention. Where possible, use berms to close road entrances as part of the decommissioning of these roads where road alignments cannot be adjusted to reduce visual impacts.	Meet visual quality objective - what is objective – Retention or Partial Retention	MODERATE : logic, experience, Handbook guidance (FSH 2309.16)	Forest Plan (1994-Amended), Forest-Wilderness S&G's (pg. 4-86 to 4-93), MA2A(pg 4-169-172), Matrix/MA2B (4-172 to 4-175) R6-REC-TP-016-90, FSH 599, FSH 2309.16
VIS4- Slash treatment plans will be implemented along high use roads where practical or applicable to reduce visible slash in the area.	Meet visual quality objective – what is objective Retention or Partial Retention	MODERATE : logic, experience, Handbook guidance	Forest Plan (1994-Amended), Forest-Wilderness S&G's (pg. 4-86 to 4-93), MA2A(pg 4-169-172), Matrix/MA2B (4-172 to 4-175) R6-REC-TP-016-90, FSH 599

## 6. Analysis Methodology, Assumptions

During the 2015 and 2016 field season, an MBS aquatics crew surveyed proposed treatment stands, making visual observations of stream type and when feasible, fish presence. Data collected included locations of the top of topographic slope breaks adjacent to streams and locations of “wet areas” including seeps, springs and wetlands. All identified features were mapped using field GPS techniques and subsequently digitized into GIS to ensure they were tracked. Zone and Forest aquatics staff field-reviewed selected areas of the project, filling in gaps and making adjustments to the initial field assessments.

The fisheries analysis area for South Fork Stillaguamish River(SFSR) Vegetation Project is the South Fork Stillaguamish River watershed (HUC10 – 1711000802), which is the area affected both directly and indirectly by the proposed vegetation treatments, connected actions, and mitigations, over both the short-term and the long-term. The fisheries analysis area also includes the Canyon Creek subwatershed that starts at RM 33.7 of the SFSR. The analysis does include mention of all pertinent federally listed, and MBS management indicator fish species, plus specially designated habitats, even if they occur outside the analysis area. Fishery resources are affected by watershed processes, so this should not be inconsistent with analyses completed for hydrology and soils resources.

Riparian Reserve widths were modeled using GIS and a mix of existing data along with aquatic surveys of the vegetation management units conducted in 2015 and 2016.

Effect determinations will be made for the fish species and habitats of special interest (those with special designations). Effects to viability of Management Indicator Species are made at the Forest scale. Effects of the proposed project activities to Aquatic Conservation Strategy (ACS) objectives are made at various scales, depending on the objective. Projects must be evaluated at both the project and watershed (5<sup>th</sup> field, or HUC10) scales. ACS consistency is described in the North Zone Hydrologist report.

Fish utilization was analyzed using a combination of Washington State Department of Natural Resources’ interactive mapping tool Forest Practices Application Review System at <http://fortress.wa.gov/dnr/app1/fpars/viewer.htm>, direct observations, SalmonScape, the WDFW interactive mapping tool at <http://apps.wdfw.wa.gov/salmonscape/map.html> and the Stillaguamish Watershed Chinook Salmon Recovery Plan (SIRC 2005). River miles were generally derived from Williams et al., 1975.

Two alternatives are analyzed, a no-action alternative, and the proposed action:

### **Alternative 1 – No Action**

No vegetation management would occur in the project area. No connected actions for vegetation, wildlife, fish, roads, recreation, fuels, or scenery would be implemented. Roads, trails, and culverts would remain in their current states, other than routine maintenance as funding permits. Stands in the project area would continue to be overstocked, with a lack of structural diversity. Early seral habitat would continue to be limited. Timber would not be produced and revenues would not be obtained.

## **Alternative 2 – Proposed Action**

The Proposed Action consists of forest stand management and connected ground-disturbing actions, road management actions, aquatic restoration actions and recreation management. Thinning treatments would be applied to a portion of the stands within the 65,000 acre project area. Road management maintenance levels would be changed to better align the road system maintenance with projected uses, and remove existing fish migration barriers to improve aquatic organism passage. Recreation sites in proximity to stand treatment areas would be upgraded to better meet needs identified at existing trailheads and travel routes

### **Summary of the Proposed Action**

The proposed action includes the following components:

- Forest Vegetation Management
  - Non-commercial thinning of densely stocked stands (walk-in, cut and leave downed trees)
  - Commercial thinning of stands by removal of timber with the connected actions necessary for stand treatments
- Other Actions within the Project Area
  - Access management with road treatments (upgrades, storage, and decommissioning).
  - Trail and trailhead upgrades and visual quality management.
  - Aquatic organism passage improvements

#### **Forest Stand Treatment - Non-commercial Thinning**

Non-commercial thinning is the cutting of trees that are limiting growth and development of the forest stand, but are not large enough to produce harvested materials with commercial value. There are approximately 4800 to 5700 acres that would benefit from spacing of residual trees in non-commercial thinning where trees would be cut and left on-site. Prescriptions for the non-commercial thinning activities may include heavy thinning to provide for big-leaf huckleberry growth or stand development for a diversity of bird habitat. The total amount of acres treated would be determined by the funds generated by the commercial thinning in the project as well as other funding sources in future years.

#### **Forest Stand Treatment - Commercial Thinning**

There are up to 7200 acres of second-growth stands within 0.5 mile of an open roads, but not all of those acres would have thinning treatments. A range of approximately 30 to 50 percent of the potentially commercial stands (2160 to 3600 acres) would have ground-disturbance activities from proposed thinning. The range of acres that would be treated is based on the resource exclusions listed below as well as mitigations and best management practices.

The total acres would be determined during layout of the thinning units with the following second growth areas excluded from commercial thinning activities:

- no-cut buffers on fish-bearing, perennial and intermittent streams wetland and unstable soil areas
- areas of potential marbled murrelet nest trees,
- areas already exhibiting diversification of stand structure,
- areas dropped due to logging feasibility constraints and areas dropped due to uneconomical road reconstruction costs.

Thinning acres would be influenced by other resource considerations including hydrology, wildlife, fish and recreation.

### **Commercial Thinning – Fisheries and Hydrological Considerations**

All perennial non-fish bearing streams would have a minimum of 30 feet of protection from harvest equipment and tree cutting. Ponds, wetlands, seeps, springs, and unstable soil areas would also have at least 30 feet of protection. A 100-foot minimum buffer (with no planned activities) would be established on fish-bearing streams including those streams designated as critical habitat for Puget Sound Bull Trout, steelhead, and Chinook salmon.

### **Commercial Thinning – Wildlife Considerations**

Thinning would be designed to promote murrelet and owl nest structure, provide habitat connectivity and improve diversity of songbird habitat in riparian areas. The proposed action would:

- Not cut trees greater than 20 inches DBH (LSR guideline)
- Retain second growth suitable nesting structure within treated stands
- Protect raptor nests by applying no action buffers around known nest sites
- Retain pockets of snag habitat created by disease, insects or other natural agents.

### **Commercial Thinning – Recreation Considerations**

The project area overlaps with a high-use recreation area and a scenic by-way route with Forest visual quality objectives. The project design and mitigation measures would minimize impacts of project implementation on recreation and visual quality where and when feasible. The project would:

- Meet visual management objectives along the Mt. Loop Scenic By-way and routes to major trailheads with variable density thinning and buffers along trails.
- Provide 100 foot no-cut buffers on Heather Lake
- Relocate the Sunrise Mine and Walt Bailey (Mallardy Ridge) trailheads back to a location that would provide better parking opportunities than current road-end parking. Convert abandoned road sections to trail with a hydrologically stable route
- Minimize the duration of impacts to recreational access by limiting the number of trails closed at a given time, implementing complete road closures to shorten project duration or

time needed to complete thinning activities, and minimize road and trail closures on weekends and holidays.

- Target road closure (Road 42) to Heather Lake trailhead for late season from after Labor Day in September to October 15th, but road closures of Road 42 may be implemented for public safety during the summer season for short durations.
- Retain roads open to trailheads on the weekends and holidays (unless unforeseen safety situations arise).

Upgrade roads, hiking trails and trailheads to reduce sediment contributions to the watershed, and provide safe recreation opportunities.

### **Commercial Thinning – Treatment Description**

Commercial thinning would be applied on 2160 to 3600 acres. In this project the treated Riparian Reserve areas would not receive a different prescription than upland Late Successional Reserve slopes due to the similarity in the thinning objectives for desired forest vegetation and structure. The proposed riparian thinning represents approximately 7 percent of the total Riparian Reserve acres in the project area (Fisheries Specialist Report – Chapter 3). All treated acres would emphasize forest stand development and enhancement of old forest characteristics, including species and structural diversity, and recruitment of coarse woody debris. The thinning description would provide the following:

1. Stands would be thinned to target relative density 35 ( $RD = BA/(QMD1/2)$ ) using a variable density thin from below, incorporating irregular spacing and clumps of residual trees, as an intermediate treatment (not stand regeneration). The thinning would remove primarily smaller trees to allocate additional growing space to remaining larger trees. Thinning would generally remove trees of the most abundant conifer species, while leaving less abundant conifer species and hardwood species in the stand. Minor species would be favored for retention. The residual trees would generally be dominant or co-dominant, and may include trees with damage or defects such as root rot, multiple tops, spike tops, bear damage, and dwarf mistletoe that contribute to structural complexity and diversity within the stand and have potential to develop future snags, nesting cavities, and nesting platforms.
2. Heavy thinning areas would be used to emphasize large tree growing space and increase understory vegetation. Thinning would be from below to approximately 20-50 trees per acre, retaining hardwoods and minor conifer species. Heavy thinning areas would be approximately ½ acre to 3 acres in size and cover approximately 3-10 percent of the stand area. Heavy thinning would only be prescribed in stands or areas with low windthrow potential.
3. Gaps would be created to increase stand heterogeneity, and culture individual trees specifically for big crowns and limbs. All conifers larger than the minimum diameter limit (for merchantability) and less than 20 inches DBH would be removed from gaps, while all hardwoods would be retained. Gaps would be approximately ¼ to ½ acre in size and cover 3-10% of the total stand area and avoid be located immediately adjacent to old growth forest or potential nest trees.
4. Skipped areas would retain uncut, densely stocked areas in at least 10 percent of the stand area. Areas within stands proposed for treatment that would be left un-thinned include

riparian no-cut buffers, hardwood and minor species areas, plant protection buffers, and areas otherwise unsuitable for commercial thinning. Additional skips may be designed as needed in stands that lack these features.

5. Trees greater than 20 inches DBH would not be cut. Any trees greater than 20 inches DBH that are required to be cut for safety or operational reasons, such as temporary road building, landing clearing, or log yarding, would remain on site as coarse woody debris.
6. Retain all snags and large downed wood. Snags and downed wood contribute to structural complexity and would be retained on site, undisturbed if possible with consideration for safe operational requirements. Any snags felled for safety reasons would be left on site.
7. Leave trees would be selected irrespective of whether the tree has any damage, so that trees with defects, potential cavity or nesting trees and other similar features of structural diversity may be retained in the units. In this case, the term “damage” refers to breakage, double tops, crooks, heart rots, ants, etc., that cause loss of wood volume, but usually won’t kill the tree. Trees with fading crowns or bleeding boles indicative of root disease that may infect neighboring trees and create snags and coarse woody debris over time would be favored for retention.
8. Cedar and hardwoods: Western redcedar would be retained in stands where it is not currently well represented in species composition. Thinning in dense stocked cedar areas would occur in order to release cedar from competition. All Pacific yew within the stands would be retained. Alders and other hardwoods within the stands would be retained for mollusk and neo-tropical migrant bird habitat.
9. Leave Tree Protection: Limit skyline corridors to 15 feet in width where possible and include guy trees as part of the thinning prescription to reduce impact to residual stand (that is, if a guy tree is the largest tree in its vicinity and would otherwise be the “leave-tree”, substitute the next largest tree as the “leave tree”). Tailhold trees that are damaged during operations would be retained and contribute to snags or coarse woody debris on site.
10. Potential Nest Tree protection: Marbled murrelet potential nest trees and old-growth legacy trees would be protected with retention of the adjacent tree(s) with interlaced or interlocked branches (typically 20 ft. radius). Potential nest trees are defined as having the features listed below:
11. Branch structure (or mistletoe broom) providing horizontal platform(s)  $\geq$  4 inches wide, 33 feet above ground or higher.
12. Coarse woody debris: Coarse woody debris (CWD), dead and down wood on the forest floor, existing on the site prior to thinning and exceeding 21 inches in diameter may be moved for access, but would not be removed from the site. Disturbance of existing CWD exceeding 21 inches in diameter would be minimized to conserve CWD in the stands proposed for treatment.
13. Snag protection: Any legacy snags found in the stands would be buffered with a no-cut buffer radius equal to or greater than the height of the snag to protect forest workers and keep snags on site. In addition, all other snags would be retained unless they pose a hazard to human safety. Where possible, skips would be placed in locations that incorporate snags.
14. Soil Protection: Where skyline harvesting systems are used logs would be yarded with either full or single-end suspension. Where skyline corridors cross no-cut riparian buffers, full suspension would be maintained over the riparian buffer area. Any trees felled for corridors within riparian no-cut buffers would be left on the ground. Skyline corridors should be kept

away from snags when possible. Where ground-based logging systems are used felling (if not by individual fellers) would be accomplished in a single pass of equipment. Skid roads would be approved by the sale administrator and equipment would travel on operationally generated slash as much as possible to minimized soil disturbance and compaction. Skid roads and trails would be spaced as widely as possible. Existing skid roads and trails should be used where possible. Temporary roads and skid trails would be closed after logging. Big, old stumps would be kept intact and not uprooted wherever possible.

## Logging Systems

This project proposes to use both skyline and ground based logging systems. Skyline logging systems use cables to transport logs to the landing. While transporting logs to the landing, logs are suspended on one end or are fully suspended, reducing soil disturbance. In skyline logging systems, trees are typically felled manually using chainsaws. In some cases, where soil protection goals can be met, mechanical felling equipment is used to pre-bunch the logs along skyline corridors.

Ground based logging systems can include numerous variations and combinations of equipment. Ground based systems typically used in this vicinity usually involve one of two primary methods of transporting the logs to the landing. Both systems use mechanical felling equipment in most cases. The most common method of transporting logs to the landing after felling uses a tractor or rubber-tired skidder to pull the logs along the ground behind the skidding equipment. Another commonly used piece of equipment for transporting logs to the landing is a forwarder. Forwarders transport logs off the ground in a bunk, generally causing less ground disturbance than a rubber-tired skidder or tractor. Traditional ground-based logging systems are used on slopes up to 35 percent.

Tethered assist ground-based systems may be used on steep slopes using a winch system to improve safety and efficiency of ground-based equipment while also reducing soil impacts from the felling and yarding operations. Tethered assist systems have been used on steep slopes (up to 80 percent) that have been logged in the past using skyline logging systems. The tethered systems use a cable anchored upslope of the felling and yarding equipment to assist with traction and gradeability of the equipment (Sessions, et. al. 2016).

Approximately 2,160 acres to 3,600 acres of stands within the planning area would be commercially thinned, using both ground-based and skyline logging systems. Approximately 650 to 1,080 acres would be harvested with traditional ground based equipment operations on slopes of less than 35 percent. The rest of the 1,510 to 2,520 acres would either be skyline logged or potentially use self-leveling equipment on slopes up to 50 percent or more recently developed tethered equipment on steeper slopes. Use of ground base equipment or tethered equipment decreases worker exposure to multiple hazards in the logging operations.

## Forest Stand Treatment - Connected Actions

The proposed action would include the following connected actions associated with the timber harvest described above. These connected actions include management requirements and mitigation measures described in Section 2.2

## National Forest System Roads

To facilitate the commercial thinning, the Proposed Action would require use of both open and closed National Forest System roads.

Use of 57 miles of open Forest System roads. Actions associated with use of these roads would be normal routine road maintenance on all the miles with spot reconstruction. Timber purchasers would be required to perform road repair and maintenance work as a condition of timber-sale contracts prior to using the roads. Road maintenance and repair would include rock resurfacing, blading and shaping road surfaces, roadside brushing and cleaning drainage structures.

Reopening 29 miles of now-closed Forest System roads (stored ML 1), and closing them (storing) after use. Reopening of roads may include reconstruction, fill repairs, culvert replacements, asphalt repair, road re-surfacing and bridge repairs. A variety of repairs should be anticipated from rock-surfacing, ditch clearing to drainage improvements. Temporarily opened stored roads would be hydrologically treated, waterbarred and closed through the timber sale contract after harvesting activities.

Daylighting of the road prisms used as haul route would be for safe passage of heavy equipment and reduction of tree debris fall that could plug or redirect drainage flows resulting in road erosion and impacts to streams. This would remove primarily the overhanging hardwoods within 30 ft. of the road edge and the removal of hazard trees (both conifer and hardwoods) up to 50 ft. from the road edge that are leaning into the road prism or otherwise posing a threat to safe use of the road prism.

Fish barriers or barriers (e.g. failed or hanging culverts) to other aquatic organism passage (e.g. failed or hanging culverts) on roads would be removed or replaced to promote aquatic habitat connectivity throughout the project area.

## Temporary Roads

To facilitate harvesting of stands without open roads, the project would use on a temporary basis a number of unspecified or non-system road segments (12 miles) as well as use of road prisms from previously constructed temporary roads (16 miles) and 1.5 miles of new temporary road for a total of approximately 30 miles of temporary roads. The use of old system roads and temporary roads previously used in past timber harvest would limit the amount of new temporary road construction to 1.5 miles. The proposed action would allow for the removal of residual culverts in temporary roads and reconfigure drainage problems where old roads have intercepted or redirected flows.

Reconstruction of 12 miles of unspecified Forest System roads and reconstruction of 16 miles of former temporary roads, closing them after use. Work includes reestablishing a safe road prism, road re-surfacing with drainage improvements. Temporarily opened roads would be hydrologically treated, waterbarred and closed after harvesting activities.

Construction of 1.5 miles of new temporary roads with decommissioning of the roads following thinning activities.

Open roads would be retained to administrative and recreational destinations. Closed roads and temporary roads would be reopened as summarized above and then closed to future use as described in the transportation section.

## Rock Sources

To facilitate haul on system and temporary roads, some road surface rock would be required. Some of the surface rock for these roads may be supplied from commercial sources. However, rock also would be extracted and used from existing rock pits and one new site with potential for blasting and ground disturbance. All rock pits are located on National Forest System (NFS) lands:

- Blackjack (Rd 4031-015)- existing
- Boardman (Road 4020) - existing
- Pilchuck (Road 4240) - existing
- Green Mountain- five existing sites
  - Road 4111,
  - Road 4110
  - Road 4110-024,
  - Road 4113-012 and
  - Road 4110 second switchback at junction with temporary road
- Beaver Creek (Rd 4062-030) - existing
- Lower Pilchuck ( Road 42 at MP1.6) - existing
- Road 4210, at MP 0.08 - new rock site development
- Road 4210, existing site approximately 1.0 MP
- Road 4250, existing rock site

Use of any additional rocks sources located during the project layout would be assessed for use at that time with resources specialists from the Forest.

## Water Sources

To facilitate road construction and maintenance as well as fire protection, water may be needed. Water drafting sites would be identified during project implementation. Water removal would be primarily along the main stem of the S.F. Stillaguamish and major tributaries at sites designated as per best management practices in Section 2.2.

## Fuels Treatment

- Activity fuels (slash and fuel material created from the thinning activities) within stands would not be treated due to the fuel loading at a project scale would not exceed Forest Plan objectives

- Slash on landings and the upslope side of roads would be disposed of (see below) when the following conditions are met: 1.) the road remains open to the public post treatment, 2) the slope is greater than 20 percent and 3) the slope is of a southern or non-northerly west aspect (azimuth from 270° counterclockwise to 112°).
- Slash disposal at landings would remove project fuels from within 150 feet uphill of these landings and from within 50 feet below or on flat ground adjacent to these landings.
- Slash disposal on open roads would remove project fuels from within 150 feet uphill of the open road.
- Slash disposal options may include a combination of the following; (1) redistribution of slash in the unit 2) piling and burning at the landing according to normal stipulations that protect air quality and standing live timber, (3) chipping and spreading to a depth of no more than 4 inches, and (4) allowing for removal as fire wood (public firewood permits).
- Whole-tree yarding would be permitted, but would have mitigations to prevent large accumulations of slash at log landings along roads that would remain open to the public.

#### Other Vegetation Management

- Treat invasive plants throughout the project area as per the
- Revegetate areas of bare soil where designated (best management practices)

#### Other Activities within the Project Area

##### Recreation Site Improvements

The proposed action includes improving the condition of recreation sites and amenities in key recreation sites throughout the project area. Many recreation sites along the Mountain Loop Scenic Byway have outdated toilets, and do not have safe parking or sufficient parking capacity for the current level of use. The proposed action would upgrade toilet facilities at both Boardman Lake and Coal Lake trailheads. The proposed action would also remove culverts from the road section (Road 4063) that is part of the Perry Creek Trail and reconfigure the crossings for trail use. **Figure 2-7** displays recreational sites within the project area and proposed recreational enhancements. The proposed action would include the following trailhead actions:

##### Heather Lake Trailhead Expansion

The Heather Lake parking lot which currently has space for roughly 25 vehicles is filled to capacity on most weekends and holidays throughout the year causing visitors to park along both sides of the road which constricts traffic going to Mt. Pilchuck Trailhead and causes safety concerns for pedestrians walking along the roadside. The proposed action would expand the parking lot from approximately 25 parking slots to 75 by removing 1 acre of vegetation on the north side of the parking lot perimeter. Brush, rocks and most trees within the 1 acre footprint would be removed. Wheel stops would be installed in the new parking slots. The total area of new disturbance would be approximately 1 acre.

##### Sunrise Mine Trailhead Relocation and Expansion

Similar to Heather Lake, this popular destination is often overcrowded causing visitors to park along both sides of an already narrow Forest road causing unsafe conditions for drivers driving on both sides of the road during the busy summer season. The proposed action would relocate the Sunrise Mine Trailhead back to a flat ridge approximately ½ mile north of the existing trailhead. The section of road between there and the current road end would be decommissioned and converted to trail following completion of stand treatments.. Parking space for approximately 75 cars would be provided for the trailhead and picnic site combined by removing approximately 1-2 acres of vegetation along the east and west sides of the existing road.

### **Walt Bailey Trailhead Relocation and Expansion**

Similar to Sunrise Mine, this trailhead would be relocated approximately 1 mile back along the road from its current location in a former log landing site. The section of road between there and the current road end would be decommissioned and converted to trail following completion of stand treatments. Parking slots for approximately 30 vehicles would be provided by removing less than ¼ acre of vegetation within a total area of disturbance of approximately 1 acre..

### **Aquatic Organism Passage Site Improvements**

The proposed action includes improving the condition for aquatic organism passage in key sites throughout the project area. Culverts identified as barriers to fish migration within the project area would be replaced or removed as part of the proposed action alternative or as resources become available. The barriers that exist on proposed haul routes would be upgraded (where needed for safe road use) while barriers that exist on closed roads would be removed as resources are available through the project actions or external funding. For barrier treatments, the objective would be to simulate physical conditions found in the natural stream environment. Channel crossing would be designed with information on channel dimensions, slope, and streambed structure so that water velocities and depths mimic natural hydrological conditions (USFS 2008). Thus, the simulated channel would present no more of an obstacle to aquatic animals than the natural channel.

Implementation of the above would require ground disturbance, largely within the road prism at the fish barrier location, but may include 25 to 50 feet in all directions to re-establish channel profile and/or floodplain habitat. The use of heavy equipment may require removal of ground cover, understory vegetation, and trees within this area for safe operation and full channel restoration. All areas of ground disturbance would be mulched or re-planted with native vegetation. Typical fish passage projects could close roads completely or to one lane for up to eight weeks depending on the size of the project.

### **Access and Travel Management**

This project provided an opportunity to begin the needed assessment of recommendations in the Sustainable Road System Report (2015) for the road system within the project area of the SF of the Stillaguamish (Purpose and Need 1.3). Alternative 2 would:

- Decommission approximately 14 miles of National Forest System road no longer needed for forest management (currently non-drivable)

- Store approximately 14 miles of National Forest System roads and retain approximately 59 miles of National Forest System road in closed status Maintenance Level 1 (48 miles analyzed in Alternative 2), for a total of 73 miles in ML1 (63 miles analyzed in Alternative 2) for closed road status.
- Retain approximately 20 miles of National Forest System road in Maintenance Level 2 (16 miles analyzed in Alternative 2) for high clearance vehicles.
- Designate approximately 7 miles of National Forest System road as administrative closed Maintenance Level 2a (gated roads).
- Retain approximately 53 miles of National Forest System road in Maintenance Level 3, currently drivable passenger comfort ML (40 miles analyzed in Alternative 2)
- Retain approximately 5.26 miles of National Forest System road in Maintenance Level 4 (currently drivable – passenger comfort ML) (5 miles analyzed in Alternative 2).
- Convert approximately 1.8 mile of National Forest System road (3 road segments) into trail
- Retain 23.4 miles of former National Forest System Road (dropped from current system list in the Forest database) for use as temporary roads and treat for aquatic restoration needs.

Treatment Name and Description	Treatments by Maintenance Level		
	Decommissioned Roads ML0	Closed Roads ML1	Open Roads ML2-5
<b>Passive Management</b> - Road has not been used in recent past, vegetation has naturally overgrown the roadbed and natural drainage patterns are functioning at a high level. Appropriate on roads past active treatment areas.	X	X	
<b>Active Entrance Treatment</b> – gate, berm, or otherwise block entire width of roadway. Road is allowed to revegetate naturally, and drainage patterns are allowed to function as-is.	X-	X	
<b>Active Treatment</b> – gate, berm, or otherwise block entire width of roadway. Would also include additional treatments from the following list:	X	X	
<b>Full Width Decompaction</b> – complete disturbance (de-compaction) of the entire width of the roadway for up to 18” depth by mechanical construction equipment. (This includes commonly describe techniques such as “Pavement Ripping” where asphalt pavement exists.)	X		
<b>Partial Area Decompaction</b> (Craters) – localized, relatively small (approx. 3’ x 3’ wide) patterned de-compacted zones (known as “craters”) established by mechanical construction equipment in the	X		

Treatment Name and Description	Treatments by Maintenance Level		
	Decommissioned Roads ML0	Closed Roads ML1	Open Roads ML2-5
roadbed (aka moonscaping).			
<b>Minor Drainage Improvements</b> – generally include the construction of water-bars, swales, rolling dips, and other water conveyance techniques to minimize localized erosion potential. May include drivable rock lined waterbars on ML 2 roads.	X	X	X
<b>Minor Fill Removal/Stabilization</b> – generally involves localized removal of unstable fills and pulling back road shoulders in hill-side construction areas where cut/fill techniques were used to balance cuts and fills. The intent in this case is not to fully restore natural (pre-road construction) contours.	X	X	
<b>Minor Culvert Removal</b> – for both cross-drains and stream crossings generally involves removal of smaller diameter pipes (less than 36”) and shallow fills (less than 10 ft), stabilization of adjacent slopes, re-establishment of natural drainage patterns.	X	X	
<b>Major Culvert Removal</b> – for both cross-drains and stream crossings generally involves removal of large diameter pipes (greater than 36”) and deep fills (greater than 10 ft), stabilization of adjacent slopes, re-establishment of natural drainage patterns. Remove fill over large culverts and deep fills to dip drainage/reduce fill	X	X	
<b>Re-contouring</b> – generally involves complete elimination of the roadbed and re-establishing natural (pre-road construction) contours and slopes. This method is employed on hill-side construction areas where cut/fill techniques were used to balance cuts and fills during construction. The intent is to fully remove the entire presence of the roadbed.	X		
<b>Bridge Removal</b> – generally includes removal of all portions of a bridge structure including decking, asphalt paving, abutments and other appurtenances.	X		
<b>Convert road to trail</b> – activities could include laying back cut banks and moving that material to allow for recontouring the slope. Vegetation would be allowed to revegetate as much as possible to	X		

Treatment Name and Description	Treatments by Maintenance Level		
	Decommissioned Roads ML0	Closed Roads ML1	Open Roads ML2-5
achieve a natural look. Trails would accommodate, use consistent with management area allocations, and Road to trails would accommodate the use designated for the trail which the road conversion would be a part of (Perry Creek, Sunrise Mine and Walt Bailey Trails are currently limited to hiker use only). Drainages would be designed for hand tool maintenance. (Stored roads remains on system as road, but can be used as trail)			
<b>Active Maintenance</b> (e.g., brushing, signing, culvert cleaning) would occur as appropriate and when needed. May also include:			X
<b>Minor Drainage Improvements</b> – generally include the construction of water-bars, swales, rolling dips, and other water conveyance techniques to minimize localized erosion potential.			X
<b>Road stabilization</b> – repair existing road failures – includes reconstruction of road, bridge and slope stabilization (e.g., H-Pile wall, wood placement in streams).			X
<b>Stream crossing structures</b> – would be replaced to meet current standards (e.g. meet 100 year flow and AOP) as funding is available.			X

### Timing of Project Activities

Most activities would be completed within the next 15 years. Some actions related to timber sale preparation could begin at the earliest possible implementation date. Other actions, such as road to trail conversion would not begin until after thinning is completed. Connected actions may require sequencing over the 10 or more years with the commercial thinning activities which would occur over the course of several years. Road and trail maintenance activities, road decommissioning and aquatic organism passage activities, etc. would also occur intermittently, as funding becomes available through timber sales or other sources.

## 7. Affected Environment

### General

The South Fork Stillaguamish River originates near Barlow Pass on the west slopes of the Cascade Mountains of Western Washington, and flows generally westward for about 52 miles to its confluence with the North Fork Stillaguamish River. The South Fork Stillaguamish River watershed includes six field subwatersheds: Middle South Fork Stillaguamish (30,156 acres), Canyon Creek (15,455 acres), and Upper South Fork Stillaguamish (25,154 acres), North and South Canyon Creek (24,672 acres) and Headwaters South Fork Stillaguamish (21,260 acres).

The project area is characterized by rugged mountain terrain. The headwaters of the South Fork Stillaguamish rise in snowfields at up to 6,600 feet above mean sea level (msl). The assessment area contains predominantly steep, V-shaped valleys with relatively high-gradient streams. The South Fork Stillaguamish flows through a steep, confined channel including a narrow gorge (Robe Valley) between river mile (RM) 35 and RM 42. Granite Falls is a natural fish migration barrier near RM 35.5, which was modified with a fishway in 1954 (Williams et al., 1975).

The climate in the assessment area is temperate maritime. Annual precipitation ranges from 60 inches at lower elevations to 160 inches at the higher elevations. Over 90 percent of all precipitation occurs from October through May, with heavy accumulations of snow above about 1,600 feet msl. Much of the project area lies in the rain-on-snow zone between 1,000 and 3,000 feet elevation (USDA FS, 1995, 1996). These areas are characterized by large accumulations of snow followed by rapid melting under heavy rains, resulting in large peak runoff flows.

The South Fork Stillaguamish watershed provides spawning and rearing habitats for South Fork Stillaguamish Chinook salmon (*Oncorhynchus tshawytscha*), Canyon Creek Summer steelhead (*Oncorhynchus mykiss*), Stillaguamish Winter steelhead (*Oncorhynchus mykiss*) and Bull trout (*Salvelinus confluentus*), which are currently listed as Threatened under the federal Endangered Species Act, Stillaguamish Coho salmon (*O. kisutch*), odd-year Stillaguamish Pink salmon (*O. gorbuscha*), South Fork Stillaguamish Chum salmon (*O. keta*), Stillaguamish Coastal Cutthroat trout (anadromous and resident; *O. clarki clarki*), and resident Rainbow trout (*O. mykiss*).

The South Fork Stillaguamish watershed is identified as a Tier 1 Key Watershed (USDA 1994). USFS Key Watersheds contribute directly to conservation of at-risk anadromous salmonids, bull trout, and resident fish species. They also have a high potential of being restored as part of a watershed restoration program. Refugia are a cornerstone of most species conservation strategies. They are designated areas that either provide, or are expected to provide, high quality habitat. A system of Key Watersheds that serve as refugia is crucial for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species.

Throughout the Mt. Baker-Snoqualmie National Forest (MBS), there are eight fish species of interest, displaying both anadromous and resident life histories. These fish generally depend on cold, clean water, appropriately sized spawning gravels, and a variety of slow- and fast-water habitat types to meet their needs at various stages of their lives. Table 2 shows the miles of habitat these fish species have been documented to occur on the MBS.

**Table 3. Miles of documented presence on the Mt. Baker-Snoqualmie National Forest by fish species of interest.**

<b>Fish species</b>	<b>Miles of documented presence on the MBS<sup>1</sup></b>
Chinook salmon	106
Bull trout	560
Steelhead	379
Coho salmon	524
Pink salmon	220
Chum salmon	121
Sockeye salmon	158
Cutthroat trout	763
Rainbow trout	503

<sup>1</sup>*From WDFW 2002; does not include miles on National Forest System land with “suspected” occupancy, or on other land ownerships.*

### ***Fish Habitat Conditions***

Historically on the upper South Fork of the Stillaguamish near Granite Falls, there was a large falls present in a narrow canyon resulting in a barrier to fish passage. It is believed that during historic times and at certain flow conditions, only summer and winter steelhead were able to migrate to the upper reaches beyond the falls. Pink, char, chum, chinook, and coho could make it up to the falls, but could not access the miles of habitat beyond this barrier (STAG 2000).

### **Watershed Analysis and Level II Surveys—**

#### **USFS Watershed Analyses:**

The Lower SFSR and Canyon Creek Watershed Analysis (1996) analyzed the area from Canyon Creek confluence (RM 33.7) to the easternmost portion of the South Fork Lower Stillaguamish River near Wiley Creek (RM 51) including all of the Canyon Creek watershed. Sediment input from past timber practices and road related failures were anticipated to continue to degrade downstream habitat and fill in important pool habitat for juvenile rearing and adult holding for up to 20 years but during that time upgrades and decommissioning of FS roads were to minimize future road related sediment discharge. Large Woody Debris (LWD) was anticipated to be low in abundance and size class in most of the analysis area for the next 20 years due to previous

riparian timber management practices. LWD from the analysis area and the upper watershed were cited as being critical for off-forest habitat that would continue to have riparian areas with less regulatory protection.

Recommendations from this watershed analysis were for upslope restoration that would reduce rain-on-snow response, reduce mass wasting occurrence through road decommissioning and increasing stand-age, and instream restoration that would reconnect off-channel habitat and stabilize naturally occurring sediment sources (Gold Basin).

The South Fork Upper Stillaguamish Watershed Analysis (1995) analyzed the area from Boardman Creek to the headwaters of the SFSR. 65% of landslides inventoried were associated with past timber management practices and roads. Clearcuts and roads contributed to the initiation of debris flows, most significantly, in Gordon, Coal, and Blackjack creeks. Past timber management activities left little to no riparian buffers along most streams in the upper watershed, in particular, Coal and Boardman creeks. LWD was found to be woefully deficient in Coal and Deer creek compared to what was considered an acceptable condition of 165 pieces per mile. Pool habitat in the upper SF watershed was found to be limited by the natural channel geomorphology present in the watershed and, to some degree, infilling of pools from both natural and human caused landslides and debris flows. A large proportion of the tributaries and upper mainstem are high gradient, high energy systems that are dominated by cobbles and boulders that generally are not suitable for typical anadromous salmonids.

Recommendations from this watershed analysis are to upgrade and decommission roads in Coal, Boardman, Mallardy, SF below Deer Creek, and Gordon creek. Allow riparian vegetation to mature to support future reduction in stream temperature from increased canopy cover and also provide large wood to streams. Pre-commercial thinning and in some specific areas commercial thinning of riparian areas to allow for improved riparian vegetation growing conditions.

#### Region 6 Stream Inventory Level II Surveys:

A Level II survey is an extensive stream channel, riparian vegetation, aquatic habitat condition and biotic inventory on a watershed-wide scale. In the project area multiple Level II surveys have been completed that provide snapshots into the physical habitat conditions over the last 3 decades (Table 4).

Table 4. Miles of stream surveyed in the Project Area

<u>Year</u>	<u>Miles Surveyed</u>
1991	2.6
1993	5.6
1995	5.5
1996	30.1
1997	4.9
2000	1.1
2006	4.9
2009	9.3
2010	5.4

Pool habitat, large woody debris (LWD), and temperature conditions at the time of the surveys offer a snapshot of stream habitat at that time and can be used, where repeat surveys have occurred in streams, to describe change over time. These metrics also can be used as proxies when evaluating future activities that may cause a change in abundance, area, or temperature if implemented.

The number of channel widths per pool (CWP) averaged 18.2 across all surveys. There was a wide range of CWP due in part to the unique channel morphology of each survey reach (Montgomery and Buffington 1997), but expressing habitat frequency in terms of a variable length unit equal to each channel's width allows direct comparison of frequencies between channels of different size (Jackson and Sturm 2001). For instance, a stream like Deer creek had average pool spacing across reaches that ranged from (14-23 CWP) while Boardman and Blackjack creek exhibited much lower pool spacing (6-11 CWP). Most of the survey reaches exhibit plane-bed channel morphology (reach slope ~0.15-0.030) that typically under low wood loading conditions (<0.03 pieces/m) have CWP greater than 9 (Montgomery et al. 1995). The current large CWP spacing in most of the tributaries surveyed in the SF Stillaguamish suggest a lack of habitat complexity that often is provided by channel roughness elements like instream wood.

LWD frequency and abundance is also an important indicator of fish habitat quality by creating deep scour pools, sorting spawning gravel, and reconnecting floodplain habitat. The region 6 stream inventory protocol (USDA 2015) considers LWD to be any piece of wood within the bankfull width of a stream that is 36 inches in diameter and over 50 feet long and wood 24 inches in diameter and over 50 feet long to be medium woody debris (MWD). Streams in the project area had a wide range of piece counts per mile with a high of 54 in Deer creek in 1993 and a low of 1 piece per mile in Perry Creek in 2010. 80 pieces of MWD per mile is often considered a wood loading that reflects a properly functioning condition (SIRC 2005, USFWS 1998).

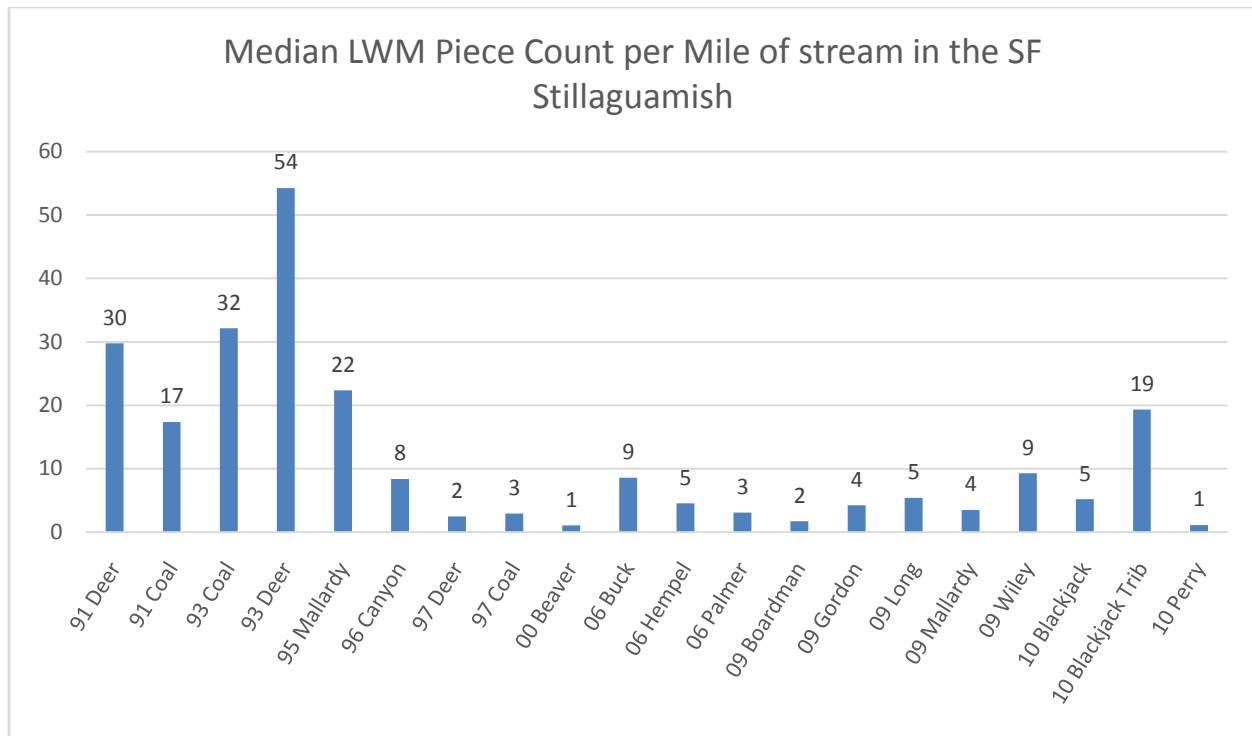


Figure 1. Wood per mile in the project area.

Incredible temporal variability exists within streams as shown by the change in LWM in Deer Creek between 1993 and 1997. Caution is advised in interpreting the data without considering all import and export mechanisms and contributions over time.

Existing stream temperature conditions in the project area are not well known. A Total Daily Maximum Load (TMDL) Study (WDOE 2004) and Implementation Strategy (WDOE 2007) were developed for the Stillaguamish basin that included monitoring of stream temperature in 2001 within the Forest boundary at Verlot Campground. Stream temperature exceeded the Maximum Daily Temperature Threshold (16°C) on 46 days during the summer, and exceeded the Maximum Daily Temperature Threshold (18°C) on 20 days (WDOE 2004). The SF Stillaguamish River is a 303d listed river for stream temperature. 303(d) list comprises those waters that are in the polluted water category, for which beneficial uses— such as drinking, recreation, aquatic habitat, and industrial use – are impaired by pollution. The Forest Service collected continuous stream temperature during the warmest summer on record (2015) near the headwaters of the SF Stillaguamish River above Palmer Creek. Stream temperature did not exceed 13°C and recorded a daily maximum stream temperature of 12.9°C on July 19, 2015 (Aquatic Surveys. Natural Resource Manager, USDA Forest Service. 31 January 2017)

#### Stillaguamish Watershed Chinook Salmon Recovery Plan—

The Stillaguamish Watershed Chinook Salmon Recovery Plan (SIRC 2005) states “*ultimate habitat recovery goal is to maintain and restore natural ecosystem conditions that sustain salmonid productivity. To achieve this goal for Chinook salmon, individual habitat parameters should at least meet the quantitative measurement known as “properly functioning conditions”*

(NMFS 1996). "The following goals laid out in the recovery plan are pertinent to the project area and the existing condition:

- 1) 80% of stream shorelines (contiguous area within the channel migration zone) having a riparian buffer width equal to or greater than one Site Potential Tree Height (SPTH) on fish bearing waters to ensure properly functioning riparian habitats.
- 2) 80 pieces (24-inch by 50-foot) of large woody debris (LWD) per mile be added and/or maintained on the mainstem Stillaguamish River and tributaries to ensure properly functioning instream wood conditions.

### Riparian Condition

Riparian (streamside) conditions are important for water quality protection. Streamside vegetation creates shade for temperature control and filters overland flow to eliminate or reduce the amount of sediment that enters the stream. Large trees that die and are blown over, or are undercut by the stream, become large woody material in the channel or on the floodplain. This large material creates channel complexity and affects riparian, aquatic, and terrestrial habitat quality. It also distributes stream energy and reduces the amount of channel erosion. The root systems of vegetation bind soil particles together, reducing bank erosion and further decreases the amount of sediment introduced to streams.

The project area was divided up by five HUC 12 subwatersheds for convenience and differences in fish utilization and access. The combined subwatershed acreage is approximately 116,700. Commercial and Non-commercial treatment is proposed for 11% of this area, 7% commercial and 4% Non-commercial respectively. The amount of commercial and non-commercial treatment per HUC12 ranges from 2-13% for commercial and 1-8% for non-commercial (Table 5.)

Table 5. Commercial and Non-Commercial Stand Acreage by Subwatershed (HUC12)					
	Total Subwatershed (Acres)	Commercial (Acres)	Pre-Commercial (Acres)	Commercial % of Subwatershed	Pre-Commercial % of Subwatershed
HUC 12					
Headwaters	21260	1220.3	902.7	6	4
Upper	25154	1999.9	1947.6	8	8
Middle	30156	3795	1326.9	13	4
NFSF Canyon	24672	484.9	471.5	2	2
Canyon	15455	368.7	166.9	2	1

Northwest Forest Plan Riparian Reserves acreage were extrapolated from aquatic resource data collected in 2015 and 2016 (and remote sensing analysis) and applied to the subwatersheds and project area to better estimate stream density and other aquatic resources found on the ground (Table 6). Due to the incredibly high density of streams and other aquatic features inventoried in 2015 and 2016, RR were estimated to apply to nearly 84% of the landscape. Only 7% of all RR in Canyon Creek and SF Stillaguamish (project area) are within the proposed action area (Table 6).

Table 6. Total NWFP Riparian Reserves acreage and Proposed Action No Thin Buffers in project area.				
	Total Watershed	NWFP RR in Stands	Proposed No thin buffer in Stands	Proposed % of RR in Watershed
Project Area	97287.6	6533.7	1213.1	7
SF Stillaguamish	63834.7	5824.9	1081.5	9
Canyon Creek	33452.9	708.8	131.6	2

Within the RR of the proposed action area, there will be “no-thin buffers” applied to all aquatic resources prior to any treatment occurring. The no-thin buffers range from 100 feet to 15 feet slope distance from aquatic resources (Table 7).

Table 7. No Thin Buffers along Aquatic Resources included in the Proposed Action

Feature	Riparian Reserve default width, Feet	Proposed Action No-Thin Buffer (slope distance), Feet
Fish-bearing streams	2 SPTH or 300	100
Perennial Non fish-bearing streams	1 SPTH or 150	30
Wetlands (> 1 acres), seeps, and springs	1 SPTH or 150	30
Unstable soils and slopes	1 SPTH or (100-150)	30
Intermittent/Ephemeral Non fish-bearing streams	1 SPTH or 100	15

The existing riparian composition and density is presumed to be very similar to the adjacent upland areas. Historically riparian areas were not protected from clearcut timber management and are often found in similar condition to the adjacent upland area. Limited stand data in the project area was used to provide estimates of riparian composition, density, and canopy cover (see Silviculture Report for details). Generally, existing riparian composition is dominated by Western Hemlock with median tree densities (trees per acres TPA) of 270 TPA and canopy cover of roughly 89% (Table 8).

Table 8. Riparian Density and Canopy Cover		
--	--	--

	<b>TPA</b>	<b>BA/Acre</b>	<b>SDI</b>	<b>QMD</b>	<b>RD</b>	<b>MBF/Acre</b>	<b>Canopy Closure %</b>
Max	734	435	738	21	127	118	98
Median	270	325	506	14	83	64	89
Mean	304	330	525	15	87	68	89
Min	152	234	376	10	62	43	79

Fish passage—

**Table 9. Confirmed Fish passage barriers on NFS lands in the South Fork Stillaguamish Vegetation project area.**

<b>Location, FS Road Number</b>	<b>Barrier Description</b>	<b>Relation to Project</b>
Monte Cristo Grade Road	05.0395A. Total Barrier to fish migration. Designated Critical Habitat for PS steelhead	On a proposed haul route, analyzed for replacement.
Monte Cristo Grade Road	Heather Creek. Total Barrier to fish migration. Designated Critical Habitat for PS steelhead	On a proposed haul route, analyzed for replacement.
Monte Cristo Grade Road	Unnamed. Total Barrier to fish migration. Designated Critical Habitat for PS steelhead	On a proposed haul route, analyzed for replacement.
4037000	0407. Total Barrier to fish migration. Designated Critical Habitat for PS steelhead	On a road in the project area, analyzed for removal.
4037000	Long Creek. Partial Barrier to fish migration. Designated Critical Habitat for PS steelhead and PS Bull Trout	On a road in the project area, analyzed for removal.
4037000	Unnamed Total Barrier to fish migration.	On a road in the project area, analyzed for removal.
4037000	Unnamed Total Barrier to fish migration.	On a road in the project area, analyzed for removal.
4037000	Unnamed Total Barrier to fish migration.	On a road in the project area, analyzed for removal.
4031000	Unnamed Total Barrier to fish migration.	On a proposed haul route, analyzed for replacement.
4031000	Unnamed Total Barrier to fish migration.	On a proposed haul route, analyzed for replacement.
4065000	Palmer Creek Total Barrier to fish	On a proposed haul route, analyzed

	migration. Designated Critical Habitat for PS steelhead	for replacement.
--	---	------------------

### ***Fish Species***

The South Fork Stillaguamish watershed provides spawning and rearing habitats for South Fork Stillaguamish Chinook salmon (*Oncorhynchus tshawytscha*), Canyon Creek Summer steelhead (*Oncorhynchus mykiss*), Stillaguamish Winter steelhead (*Oncorhynchus mykiss*) and Bull trout (*Salvelinus confluentus*), which are currently listed as Threatened under the federal Endangered Species Act, Stillaguamish Coho salmon (*O. kisutch*), odd-year Stillaguamish Pink salmon (*O. gorbuscha*), South Fork Stillaguamish Chum salmon (*O. keta*), Stillaguamish Coastal Cutthroat trout (anadromous and resident; *O. clarki clarki*), and resident Rainbow trout (*O. mykiss*).

**Table 10. Fish species of interest and special designations.**

<b>Species (Stock)</b>	<b>Status<sup>1</sup></b>	<b>Utilization Associated with Project Area<sup>2</sup></b>
Stillaguamish Fall Chinook Salmon	NMFS—Listed threatened (3/99); Designated critical habitat (9/05); Essential fish habitat FS—MIS; WA—Candidate; SaSI 2002—Depressed	South Fork Stillaguamish River up to Buck Creek at RM 67.1; same for critical habitat and EFH.
Bull Trout	USFWS—Listed threatened (11/99); Revised designated critical habitat (10/10) FS—MIS; WA—Candidate; SaSI 1998—Healthy	Throughout SF Stillaguamish River Canyon Creek including forks, numerous tributaries of the SF Stillaguamish river. Critical habitat is designated in the following: Canyon Creek (SF and NF included) Mainstem SF Stillaguamish River Perry Creek Big Four Creek Beaver Creek Coal Creek Deer Creek Bender Creek Blackjack Creek Mallardy Creek Gordon Creek Boardman Creek Long Creek Schweitzer Creek Silver Gulch

Species (Stock)	Status <sup>1</sup>	Utilization Associated with Project Area <sup>2</sup>
		Long Creek
Stillaguamish Winter/Summer steelhead	NMFS—Listed Threatened (5/07; anadromous only); designated critical habitat 03/2016) FS—MIS WA—Not Classified; SaSI 2002— Healthy	Throughout SF Stillaguamish River Canyon Creek including forks, numerous tributaries of the SF Stillaguamish river. Critical habitat is designated in the following: Bear Creek Beaver Creek Bender Creek Benson Creek Black Creek Blackjack Creek Boardman Creek Buck Creek Canyon Creek Coal Creek Cranberry Creek Deer Creek Eldredge Creek Gordon Creek Hawthorn Creek Heather Creek Hempel Creek Long Creek Mallardy Creek Marten Creek North Fork Canyon Creek Palmer Creek Perry Creek Rotary Creek Schweitzer Creek Silver Gulch South Fork Canyon Creek South Fork Stillaguamish River Triple Creek Turlo Creek Twentytwo Creek Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed

Species (Stock)	Status <sup>1</sup>	Utilization Associated with Project Area <sup>2</sup>
		Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Unnamed Wiley Creek Wisconsin Creek
Stillaguamish Coho Salmon	NMFS—Candidate; Species of Concern (7/95); Essential fish habitat FS—Sensitive, MIS; SaSI 2002—Healthy	Throughout SF Stillaguamish River Canyon Creek including forks, numerous tributaries of the SF Stillaguamish river. Same for EFH
Stillaguamish Pink Salmon	NMFS—Not Warranted (10/95); Essential fish habitat FS—MIS; SaSI 2002—Healthy	Throughout the mainstem SF Stillaguamish River, Canyon Creek including forks. Same for EFH.
South Fork Fall Chum Salmon	NMFS—Not Warranted (3/98) FS—MIS; SaSI 2002—Healthy	Canyon Creek and Forks
Coastal Cutthroat Trout (Snohomish)	NMFS—Not Warranted (4/99) FS—Sensitive, MIS (anadromous and resident); SaSI 2000—Unknown	Anadromous Coastal Cutthroat trout in South Fork Stillaguamish River and major tributaries and native residents in all fish-accessible tributaries
Sockeye Salmon (Baker River stock)	NMFS—Not Warranted (Baker River stock in Skagit; 3/99) FS—Sensitive (Baker River)	No Baker lake sockeye in the SF Stillaguamish watershed.

<sup>1</sup> NMFS—National Marine Fisheries Service; FS—Forest Service (USDA FS 1990 and USDA FS 2008); USFWS—United States Fish and Wildlife Service; WA—Washington State Threatened and Endangered status at <http://wdfw.wa.gov/conservation/endangered>; SaSI—Washington Salmonid Stock Inventory (WDFW 1998, 2000, 2002); MIS—Management Indicator Species (from USDA FS 1990).

<sup>2</sup> Sources: WDFW interactive SalmonScape mapping tool at <http://apps.wdfw.wa.gov/salmonscape/map.html>; Williams et al. 1975,

## 8. Environmental Effects (includes Cumulative)

## Alternative 1 – No Action Alternative

The analysis area for direct and indirect effects on fishery resources is the mainstem South Fork Stillaguamish River from Cranberry Creek at about river mile (RM) 42.8 to the headwaters of the South Fork Stillaguamish River at RM 70.2, The Canyon Creek subwatershed, plus tributaries draining to this area. The project has three primary elements that could affect fish habitat or fish: Riparian Reserve Timber Stand Treatment (including effects of logging systems), Road Use (including road reconstruction, maintenance, hauling, and water withdrawals), and Road Treatments (including road decommissioning and closure). Each of these elements are considered separately, along with additional connected actions for each alternative.

### **Alternative 1—No Action**

#### *Direct/Indirect Effects on Fish Habitat*

There are no direct effects of the no action on fish habitat.

#### *Indirect Effects:*

##### *Stream Temperature from Riparian Treatment*

Seven percent of riparian reserves in the South Fork Stillaguamish and Canyon Creek subwatersheds are included in the proposed action. Under the no action alternative there would be no treatment of these riparian areas. Based on modeled results of riparian condition 50 years from the current condition (2066), riparian canopy cover would largely stay the same as existing condition (89%) increasing to an average canopy cover of 91% (range 83% - 95%).

Non-commercial thinning, cutting of trees that are limiting growth and development of the forest stand, but are not large enough to produce harvested materials with commercial value would not be implemented on approximately 4815 acres. Similar effects as described below for commercial treatment, but to a much lesser degree, are assumed for non-commercial thinning so they will be combined for ease of analysis throughout the specialist report.

Implementation of the no action alternative would not result in a change in stream temperature. The no action alternative would have no indirect effect on water temperature within or downstream of the project. Since no treatments would be employed on proposed thinning units or roads under the no action alternative, stream temperature reductions are likely to continue into the future as vegetation reaches maturity, but these temperature reductions would occur at a slower rate than the proposed action. Without thinning riparian reserve areas, these trees are expected to be constrained by competition and not grow as large before they die.

##### *Sediment from Road Use*

Roads would not be used as timber haul routes, increases in frequency and duration of loaded and unloaded logging trucks and heavy equipment would not occur. Sediment production from such activities would not occur. There would be no effect on fish habitat.

### *Sediment from Road Treatment*

Approximately 57 miles of existing system roads would not receive project directed reconstruction, maintenance and use. An additional 29 currently closed roads would remain closed, and 28 miles of existing non-system roads would not be reconstructed and used, nor 1.5 miles of new temporary roads would be constructed.

Approximately 14 miles of road would not be designated for decommissioning, nor 14 miles of road designated for storage.

There would be no change in the existing road densities in the subwatersheds. The existing mechanisms for sediment delivery would remain unchanged. The existing mechanisms for sediment delivery to streams would continue unchanged, including existing rilling of road surfaces, imminent or future culvert failures, and traffic-related sediment inputs. This would not change the existing condition of fish habitat, and likely lead to future degradation of fish habitat as infrastructure exceeds its life expectancy or fails due to lack of maintenance.

### *Large wood from Riparian Treatment*

Implementation of the no action alternative would largely maintain the existing availability of wood in the riparian area that could be recruited to streams. Without creating openings and changing the insolation regimes around many of the tributary corridors, near channel riparian vegetation would continue to be limited until dense stands partly die creating openings in the canopy and increasing Riparian Reserve diversity. While the smaller diameter trees in the riparian area under the no action alternative have been shown to provide important stream functions in smaller tributaries in Washington State (Jackson 2001; Beechie and Sibley 1997), the lack of mobilization and transport to fish-bearing waters (Jackson 2001) and inability to provide channel forming functions in larger fish-bearing streams (Martin and Benda 2001; ) or be retained in larger channels (Bilby and Ward 1989; Montgomery et al. 1995; Beechie and Sibley 1997) contributes less function to downstream fish habitat.

Fish habitat would be maintained under the no action alternative, but continue to have trees recruited that are smaller in diameter and less functional over a longer period of time than the proposed action.

### *Other Connected Actions*

#### Opening of Rock Pits

Rock pits will not be reopened or used. This will have no effect on fish habitat

#### Fish Passage

Eleven known fish barriers will not be removed or upgraded to allow for fish passage. Upstream habitat will continue to be inaccessible to all fish species limiting distribution and occupancy of diverse habitats.

### Recreation Improvements

Conversion of roads to trails and expanded parking lot at Walt Baily/Mallardy Ridge, Sunrise Mine Trailhead, and Heather Laketrail will not occur. This will have no effect on fish habitat.

### Daylighting and Danger Tree removal from Haul Routes within Riparian Reserves

Daylighting of the haul routes for safe passage of heavy equipment and reduction of tree debris fall that could plug or redirect drainage flows resulting in road erosion and impacts to streams would not occur. Trees will continue to provide direct input of organic matter into roadside ditches and streams, which without regular road maintenance, may increase the risk of road and stream crossing failures.

Increased risk of failure could lead to downstream degradation of fish habitat and short to long-term alteration of behavior or physiology of fishes depending on the magnitude and duration of the failure.

### *Effects on Fish*

There will be no direct or indirect effects to fish from implementing the no action alternative.

## **Alternative 2— Proposed Action**

### ***Direct/Indirect Effects on Fish Habitat***

There are no direct effects of the proposed action on fish habitat.

### *Indirect Effects:*

### Stream Temperature

### *Stream temperature from Riparian Treatment*

Seven percent of all riparian reserves estimated in the project area are included in the proposed action. Thinning would primarily be from below, removing more trees in the smaller diameter classes and leaving trees 20 inches DBH or greater. The proposed action would implement no-thin buffers (Table 7) on all fish-bearing (100 feet), non-fish bearing perennial (30 feet), and intermittent streams (15 feet), including wetlands and unstable areas (30 feet).

No thinning would occur in close proximity to streams. No-cut buffers have been prescribed on all streams, ponds, and wetlands to protect existing shade-producing trees from being cut.

Minimum no cut buffers were defined at varying distances based on site specific conditions including channel migration zone, hillslope stability, and stream type. A minimum 100 foot no cut buffer from the channel edge of all fish-bearing streams will be applied, this includes the SF Stillaguamish River. Site specific conditions exclude harvesting activities include the channel migration zone and steep facet slopes over the SF Stillaguamish River.

The intent of these no-cut zones is to protect all vegetation on hillslopes adjacent to streams, including all understory and tree species, and to retain sufficient shade to prevent solar heating of the stream. Wilkerson et al. (Wilkerson, Hagan, Siegal, & Whitman, 2006) found that 75 foot buffers with 60 % canopy closure on both sides of the stream resulted in no detectable water temperature change. Groom et al. (Groom, Dent, & Madsen, 2011) detected no difference in pre- and post-harvest stream temperatures on Oregon state forests using a 100 foot riparian management zone limited to thinning, with a 25 foot no cut buffer. Anderson and Poage (Anderson, 2014) in a studied variable buffer widths associated with harvesting timber with implementation of NWFP and the effects of these buffers on stream temperature in western Washington and Oregon. Anderson and Poage (Anderson, 2014) found that with a minimum 50 ft variable buffer width, slight air temperature increases were measured in the microclimate over streams however these increases were not sufficient to have an effect on stream temperatures. While the canopy density directly over the stream would not be affected, the angular canopy density (ACD) would be reduced thus increasing solar radiation input to the stream.

Due to the width of the no-thin buffer on all fish-bearing streams and the maintenance of existing canopy cover on all streams, there is likely a negligible and non-detectable change in stream temperature if the proposed action is implemented on the local scale. At the watershed scale only 7% of riparian reserved are proposed for treatment in the project area. Changes to watershed scale stream temperature are not anticipated.

## Sediment

### *Sediment from Riparian Treatment*

Sediment related indirect effects to fish habitat could occur from disturbance of the forest floor by heavy machinery (ground-based operation), and soil disturbance from yarding corridors and yarding felled trees that fall in the no-thin buffer area. Sediments can degrade the quality and quantity of spawning and rearing habitats by burying eggs in the gravel and filling pools. Rashin et al. (2006) found Of 157 individual erosion features determined to deliver sediment to streams during either the first or second year following timber harvest, 94 percent were located within 10 m (32 feet) of the stream. In the literature review of vegetation buffering to reduce sediment completed by Sweeney and Newbold (2014) they found that 64% of sediment could be filtered out by streamside vegetation with a 32 foot buffer and 85% for roughly 100 foot buffer.

It is unlikely degradation to fish habitat from sediment generated by stand treatments in the proposed action would occur, as all ground-disturbing work would occur at least 100 feet away from fish-bearing streams, 30 feet away from non fish-bearing streams, and 30 feet from the top of any inner gorge or unstable landform. Additionally, full suspension cable yarding is required over all aquatic resources which greatly reduces hillslope soil disturbance typically observed with single-end suspension cable yarding (Rashin et al. 2006).

### *Sediment from Road Use*

Heavy road use associated with the timber harvest can cause sediments to be mobilized from gravel road surfaces (Reid and Dunne 1984). Where roads are within 150 feet of streams, local inputs of sediment could be deposited in fish habitat (Dube et al. 2004), filling pools used for rearing or hiding. Sedimentation during spawning periods could smother eggs in the gravel. Seasonal restrictions on log haul and required installation of erosion control features (BMPs) will greatly minimize sedimentation from increased road use. Simple sediment transport rates were applied to model an estimate for the rates of sediment delivery to streams from haul routes of the South Fork Stillaguamish River Vegetation Project (See Hydrology Report). The amount of sediment that is delivered as a result of log haul to these lower reaches is expected to be below background levels and not measurable, since the natural background suspended sediment levels in drainages such as the South Fork Stillaguamish can be high. The increased sediment production from log haul, based on model results and applied across the project area, are considered to be within the range of natural variability.

In addition, there is only an estimated 0.60 miles of the approximately 190 miles proposed for use that is within 200 feet of known fish occupancy or fish habitat.

### *Sediment from Road Treatments*

Approximately 57 miles of existing system roads would receive project directed reconstruction, maintenance and use. Road maintenance, reconstruction and use would cause short-term increases in sediment while fixing drainage issues that would otherwise lead to potential failure and degradation of downstream fish habitat. An additional 29 currently closed roads would be reopened, and 28 miles of existing non-system roads would be reconstructed and used, 1.5 miles of new temporary roads would be constructed.

All temporary and new roads would be obliterated after project use. Road maintenance and reconstruction activities would improve drainage efficiency and repair existing failures. This would reduce road-related sedimentation to streams that could degrade the quality and quantity of spawning and rearing habitats.

In-water work would be done during approved in-water work windows to minimize potential effects to downstream fish habitat.

The proposed action would decommission 14 miles and store 14 miles of roads in the existing road network. Road closure and decommissioning activities could affect fish habitat through indirect short term sediment introduction, as well as long-term benefits of restoring natural hydrological and sediment transport processes.

Overall, there would be short term impacts to fish habitat from road treatment activities, but the maintenance of existing drainage structures and replacement of failed infrastructure will greatly reduce the future potential of major failures that could degrade downstream fish habitat.

### *Large wood from Riparian Treatment*

No thinning would occur in close proximity to streams. No-cut buffers have been prescribed on all streams, ponds, and wetlands to protect existing shade-producing trees from being cut. Minimum no cut buffers were defined at varying distances based on site specific conditions including channel migration zone, hillslope stability, and stream type. A minimum 100 foot no cut buffer from the channel edge of fish-bearing streams was applied, this included the South Fork Stillaguamish River. Site specific conditions exclude harvesting activities include the channel migration zone and steep facet slopes over the South Fork Stillaguamish River.

All other stream no-cut buffers would be measured back from the greater of the top of slope break or from the streambank where no obvious slope break exists. Minimum no cut distances of 100 feet to all fish-bearing streams and 30 feet from all non-fish bearing perennial streams and wet-areas/seeps and 15 feet from all non-fish bearing intermittent streams as measured from the stream bank or back from the top of the slope break whichever is greater. The retention of all stream adjacent vegetation as well as everything within 100/30/15 feet of the top of the slope break is to retain all vegetation within the current primary shade zone.

Reeves et al. (Reeves, Burnett, & McGarry, 2003) found that over half the large wood in a stream was recruited from upslope. Upslope wood recruitment would be protected by prohibiting harvest on inner gorges and unstable ground. Additions of large wood require that large trees are present to fall into the channel however. The thinning of upslope and riparian areas would allow for the remaining trees to grow larger and potentially provide larger wood debris to streams in the future than would occur otherwise. Thus, thinning in these areas could have an indirect effect on stream temperature if those trees are recruited to the stream.

Nearly all of the treatment areas are around perennial and intermittent non-fish bearing streams. The thinning of riparian areas will lead to accelerated growth in existing riparian trees and eventually provide larger trees to downstream fish habitat that will be more functional than the current smaller diameter overstocked riparian stands.

### Daylighting of Haul Routes

Daylighting of all roads used for haul routes would be for safe passage of heavy equipment and reduction of tree debris fall that could plug or redirect drainage flows resulting in road erosion and impacts to streams. This would remove primarily the overhanging hardwoods within 30 ft. of the road edge and the removal of hazard trees (both conifer and hardwoods) up to 50 ft. from the road edge that are leaning into the road prism or otherwise posing a threat to safe use of the road prism. The low volume of trees planned for removal and minimal length of road within 200 feet of fish habitat (0.15 miles) is likely to have no effect on fish or fish habitat.

### Other Connected Actions

#### Re-develop or opening of rock pits

Ten rock pits are proposed to be re-developed or opened as part of the proposed action. No fish-bearing streams are known to occur near the rock pit locations, and all erosion control measures

required for work near non-fish bearing water will be implemented. It is not anticipated that re-development or opening of these rock pits will have any indirect effect on fish habitat.

### Fish Passage

Eleven barriers to fish migration will be upgraded and/or removed as part of the proposed action. Structures known to impede fish passage at one or more life stages for Bull Trout, steelhead, Coho salmon, Coastal Cutthroat Trout, and Rainbow Trout will be treated when funding becomes available. Replacement and/or removal of infrastructure will result in re-establishing connectivity to upstream fish habitat.

### Recreation Improvements

#### **Heather Lake Trailhead Expansion**

The parking lot would be expanded from approximately 25 parking slots to 75 by removing 1 acre of vegetation on the north side of the parking lot perimeter. Brush, rocks and most trees within the 1 acre footprint would be removed. Wheel stops would be installed in the new parking slots. The total area of new disturbance would be approximately 1 acre. The parking area is bound by two large inner gorges. Fish presence in the streams below is unknown. Thirty foot setbacks from the edge of inner gorges is required. The expansion of the parking area will have no effect on fish habitat if all Forest S&Gs and mitigation measures for typical ground disturbing activities are implemented.

#### **Sunrise Mine Trailhead Relocation and Expansion**

The proposal is to relocate the Sunrise Mine Trailhead back to a flat ridge approximately ½ mile north of the existing trailhead. Parking space for approximately 75 cars would be provided for the trailhead and picnic site combined by removing approximately 1-2 acres of vegetation along the east and west sides of the existing road. Wheel stops would be installed in the new parking slots. The total area of new disturbance would be approximately 1-2 acres. The west side is the steep slope down to the SF Stillaguamish River. No known fish-bearing tributaries are in the area proposed for the new parking area. Prior to trail conversion the road would be treated to ensure that stream crossings are upgraded to meet Forest standard or removed. The expansion of the parking area will have no effect on fish habitat if all Forest S&Gs and mitigation measures for typical ground disturbing activities are implemented.

#### **Walt Bailey Trailhead Relocation and Expansion**

Similar to Sunrise Mine, this trailhead would be relocated approximately 1 mile back along the road from its current location. The section of road between there and the current road end would be decommissioned and converted to trail following completion of stand treatments. Parking slots for approximately 30 vehicles will be provided by removing less than 1 acre of vegetation. Wheel stops would be installed in the new parking slots. There are no known fish-bearing streams along the 1 mile of road proposed for road-to-trail conversion. The end of FSR 4030 follows the ridge between Boardman and Mallardy Creeks and is roughly a 90% slope down to Boardman creek. Prior to trail conversion the road would be treated to ensure that stream crossings are upgraded to meet Forest standard or removed. The expansion of the parking area and road conversion will have no effect on fish habitat if all Forest S&Gs and mitigation measures for typical ground disturbing activities are implemented.

## ***Effects on Fish***

Unless specifically brought forward, there are no direct effects to fish from the proposed action and connected actions.

### ***Indirect Effects:***

#### **Stream Temperature**

##### ***Stream temperature from Riparian Treatment***

The proposed action will increase solar radiation to non-fish perennial and intermittent streams by removing some riparian trees and creating openings in the forest canopy. Introduction of more light has been shown to promote understory and deciduous tree growth, increase primary production and benthic macroinvertebrate biomass, which has been shown to increase juvenile fish growth rates. Assuming that the increase in solar radiation does not cause an associated adverse increase in stream temperature (see Hydrology Report), which would create a bioenergetic imbalance, then the thinning treatment of the proposed action would result in a positive indirect effect to resident and anadromous juvenile salmonids rearing in the project area.

#### **Sediment**

##### ***Sediment from Road Use***

Indirect effects on fish from road use, generally assumed to be changes in road sediment runoff, would include behavioral changes including habitat use, prey capture, and predator avoidance. Those affects could result in changes to growth rate and overall fitness. Nearly all of the treatment areas are in non-fish bearing perennial and intermittent streams. With seasonal haul restrictions, required BMPs, and limited road miles within 200 feet of fish habitat, sediment is not anticipated to enter fish bearing streams in any significant quantity, and the amount that does is expected to impact fish for a very short duration.

#### **Road Treatments**

Indirect effects on fish from road treatment are similar to those of road use. A major difference is the replacement or maintenance of stream crossing structures that will require in-stream channel disturbance. Increases during in water work will increase sedimentation and cause temporary changes in habitat use, prey capture, and predator avoidance. These changes will be short in duration and low in magnitude due to required erosion control measures during activity implementation. Removal of sediment from culvert inlets and ditchlines will reduce sediment discharge over the long term and reduce failure potential of remaining infrastructure.

#### **Daylighting of Haul Routes**

There will be no direct or indirect effects to fish from daylighting of haul routes.

#### **Other Connected Actions**

### Re-develop or opening of rock pits

Ten rock pits are proposed to be re-developed or opened as part of the proposed action. No fish-bearing streams are known to occur near the rock pit locations, and all erosion control measures required for work near non-fish bearing water will be implemented. There will be no direct or indirect effects to fish.

### Fish Passage

Eleven barriers to fish migration will be upgraded and/or removed as part of the proposed action. Structures known to impede fish passage at one or more life stages for Bull Trout, steelhead, Coho salmon, Coastal Cutthroat Trout, and Rainbow Trout will be treated when funding becomes available.

#### *Direct effects of fish passage*

Replacement and/or removal of infrastructure will require isolation and dewatering of the work area. This action will require direct handling of juvenile fish to remove them from the project area. Fish captured may be injured by handling or incur physiological effects from capture procedures. Fish handling protocols and removal methods will be employed to minimize the impact to individual fish.

#### *Indirect effects of fish passage restoration*

Residual physiological effects may remain after capture and removal. Behavioral modifications are likely to remain for some time after capture and removal which may influence prey capture ability or predator avoidance. These indirect effects are assumed to dissipate over time. Fish captured will be held in recovery tanks until they exhibit movements that suggest they are ready for release.

### Recreation Improvements

There are no direct or indirect effects to fish for any of the recreation connected actions for the reasons described above in the fish habitat section.

### *Effect Determinations*

#### *Federally listed fish and critical and essential habitats*

***For federally listed fish, the effect determinations are No effect for Puget Sound (PS) Chinook salmon, May affect, not likely to adversely affect PS Steelhead and PS Bull trout. For designated critical habitat, proposed activities May affect, not likely to adversely affect designated PS Chinook salmon, PS Steelhead, and PS Bull trout critical habitat. For essential fish habitats (EFH), proposed activities Would not adversely affect Chinook, coho, or pink***

*salmon EFH. Consultation with the USFWS and NMFS has been initiated and a Biological Opinion is in the process of being completed.*

#### **Viability of management indicator species**

*The MBS management indicator species are Chinook salmon, Steelhead, Bull trout, Coho salmon, Pink salmon, Chum salmon, Sea-Run Cutthroat trout, Rainbow trout, and resident Cutthroat trout. The no action and proposed action would not affect the Forest-wide viability of these populations, and would not have a measurable change to the quality or quantity of their habitat in the South Fork Stillaguamish River and associated tributaries.*

#### **Climate Change**

Projections from climate change scenarios developed for the Pacific Northwest collectively project more precipitation falling as rain rather than snow, earlier snowmelt, lower springtime snowpack, higherrunoff and streamflow in winter and early spring, lower runoff and streamflow in summer, an extended summer low-flow period, and overall reductions in summer streamflow. In addition, substantial increases in highflows (e.g., 20-year return interval flows) are projected for autumn and winter, and substantial reductions in 7-day average summer low flows are projected for most locations in the North Cascades (Raymond et al. 2014).

Higher stream temperatures are projected throughout the Pacific Northwest that would reach thermal conditions adverse to salmon and trout spawning and rearing, and in particular the Stillaguamish River, prolong existing thermal barriers to fish migration (Raymond et al. 2014). The lower reaches of all major rivers that access Forest Service managed lands are typically key migration corridors for summer-running adult salmon on their spawning migration, indicating that thermal migration barriers and thermal stress will increase in at least some salmon populations in North Cascade watersheds with especially warm lower reaches.

Warming temperatures are also expected to have less dramatic, but wide-ranging population effects. Thermal boundaries at the edges of species distributions are expected to gradually shift upstream, competitive interactions may likely benefit species with warmer temperature tolerances, such thermal shifts upstream will reduce habitats available to native trouts like cutthroat trout and bull trout that often persist in the colder waters upstream of encroaching non-native fishes (Wenger et al. 2011).

Infrastructure in the form of roads, trail, and stream crossings will also be exposed to changes in hydrologic conditions due to climate change. The integrity and operation of the transportation network in the Mt. Baker Snoqualmie National Forest (MBS) is affected by stream channel migration and scour, landslides, and debris flows, which make it difficult to maintain fixed crossing structures and operational travel routes near streams. Projected increases in peak streamflows elevate flood risk, and sediment transport increase risks to structures, roads, and trails. During floods, roads and trails can become preferential flow paths for floodwaters. Landslide impacts to infrastructure may expand due to projected changes in soil moisture and precipitation form and intensity, particularly in autumn and winter (Raymond et al 2014). A recent analysis of stream channel morphology and climate change shifts suggest that stream bankfull widths (BFW) may increase 27%-43.5% across most of the MBS in the next 60 years

(WDFW 2016). Increased risk of failure to roads and infrastructure consequently increase the risk of damage to fish and fish habitat.

### **Cumulative Effects Analysis**

The affected area for cumulative effects analysis for the fishery resource is the South Fork Stillaguamish River above Granite Falls and the Canyon Creek drainage.

The effects of implementing the proposed action could overlap with lingering effects from past projects, with incremental effects of concurrent projects, and/or from effects of projects being planned for the near future. Effects to fish and fish habitats, if not directly improving or degrading them, would be related to sedimentation, stream temperature, and riparian condition. The past, present, and reasonably foreseeable actions with potential effects to fish habitat and fish populations overlapping with those of activities in the Proposed Action, and considered in this cumulative effects analysis for fisheries, are in Table C-1 and described in the EA.

#### Past Actions

Past effects that overlap in space and time with effects of the proposed action are industrial forest management practices on Federal, State, and private timber lands. “Legacy” or residual impacts to the fisheries resource from these activities include continued stream crossing failures, in-channel storage from past sedimentation, and road runoff. The continued adverse effect to the fisheries resource by these legacy impacts would be reduced by the Proposed Action through improving existing stream crossings, repairing road related risks, and adequately decommissioning road segments that pose a risk to aquatic resources.

Further, recent efforts (more or less 25 years) to reduce legacy road related impacts and improve instream habitat have improved habitat conditions for local fisheries resources.

Decommissioning of roads in both drainages (See Hydrology Report) have reduced road-related sediment discharge to fish habitat and improved existing sediment transport processes of stored legacy sediment.

#### Present Actions

Present effects that overlap in space and time with effects of any of the Alternatives are annual road maintenance of analysis area roads, major road repairs from flood damage along the Mountain Loop Highway, general trail maintenance, and hazard tree removal from developed campgrounds. Road maintenance activities that may occur within the analysis area, but not associated with road maintenance for the project, are likely to contribute negligible volumes of sediment to fish habitat due to timing restrictions and required mitigation measures that limit sediment discharge to fish bearing waters or waters that flow to fish bearing streams. Major road repairs that require in-water work can directly affect fish through required fish removal and relocation and increases in sediment discharge during base flow conditions which may alter both behavioral and feeding patterns of juvenile fish. Trail maintenance can increase sediment to streams via ground disturbance adjacent and within streams. The volume of sediment is minimized by timing restrictions and required erosion control measures to be implemented prior to ground disturbance. Hazard tree removal in major developed recreation sites can reduce shade to streams and reduce available large woody material that can be recruited to the river. The hazard tree program is currently mitigated by leaving those trees in the riparian area or returning them to streams and rivers as part of instream restoration projects. Increases in suspended sediment from project related activities may occur, and overlap in time with placer mining

operations, but would be separated spatially, contributing to undetectable cumulative impact to fisheries resources in the analysis area.

### Future Actions

Future effects that may overlap in space and time with effects from any of the Alternatives are future industrial forest management activities on Federal, State and private forest land. The proposed action would contribute to the removal of riparian trees and reducing recruitment volume to local streams which is a typical activity included in State and private forest management practices. 3,000 to 5,000 acres are proposed to be harvested between 2017 and 2019 on Private and State lands in the SF Stillaguamish River and Canyon Creek drainages. The cumulative area to be treated by Federal, State, and private timber management is roughly 11% for both drainages. The relationship of percent basin harvested and increases in stream temperature was investigated by Pollock et al. (2009) and found that for small watersheds along the Olympic Peninsula in Washington that had been clearcut between 25%-100% within the last 40 years were strongly correlated with increases in stream temperature. The conclusions, similar to Borofske et al. (1999) and Bourque and Pomeroy (2001) were that removal of vegetation exposed soil and shallow groundwater to increased solar radiation, air temperature, and wind speeds that ultimately caused an increase in stream temperature independent of existing riparian buffers or their widths. All the stands proposed for treatment are estimated to be over 40 years old (average – 49 yrs old) and percentage of individual basins treated is substantially lower than 25% (range 2-9%).

### Cumulative Effects Summary

The cumulative effect of the proposed action, combined with past, present, and future foreseeable actions, is a contribution to a positive trend towards reducing road-related sediment production. No change in stream temperature is anticipated (See Hydrology Report) and large woody material recruitment may be reduced in volume in the short term but is anticipated to provide larger trees to streams in the future. Table C-1 below lists actions within the vicinity of the project area which may have effects that spatially and temporally overlap with the projected effects of the project. Future projects are listed first, followed by present ongoing projects, followed by past projects. The table is intended to be a screening mechanism for possible cumulative effects described in Chapter 3.

**Table C-1. Past, Present, and Reasonably Foreseeable Future Actions for Cumulative Effects Analysis**

Activity	Extent	Timing/ Comment
<b>Future Actions</b>		
Future timber harvest on private and state lands (SF Stillaguamish and Canyon Cr to the east of their junction)	Extent is unknown, private and state timber lands to the west of the forest boundary.	No currently known FPAs for state or private lands. Based on past FPAs, expect 3000 acres next decade in drainage.
Gold Basin Sediment Reduction Project	Gold Basin Riparian area	Draft EA out. Implementation projected for 2017 or 2018

Campground/Rental Maintenance - Hazard Tree removals	11 Campgrounds from Turlo to Beaver Creek campground, and Picnic areas (Hemple, Big 4)	Yearly
ERFO Road repairs	Includes sites on rd. 4065 and 4052	NEPA in 2017, Implementation in 2017/ 2018
Mt. Loop Road maintenance	Road cleared, roadside brushed	yearly
Secondary Road and Trail Maintenance	Secondary road brushed every 3 years, grade/blade 2 times per year. Rock pit maintenance, Trail maintenance –yearly.	Yearly
Ice Caves Bridge Repair & Boardwalk Upgrade	Trail between Ice Caves parking lot and south bridge abutment	NEPA - 2017 Implementation - 2018
Camp Silverton Building removal and permit transfer to USFS	Decommission sites adjacent to the Stillaguamish River.	Projected for 2017
Coal Lake SNOTEL - installation of new SNOTEL site equipment	Construction of standard sensor configuration including a snow pillow, a storage precipitation gage, and a temperature sensor.	NEPA and construction 2017 – funding provided in a FWS grant to Sauk-Suiattle Tribe and NRCS
DNR Sustainable Trail Plan in the Morning Star Natural Resource Conservation Area	Trail planning for Morning Star Conservation area in the SF Stillaguamish and Upper SF Sauk River drainages and Spada Lake area	Planning in 2017 with a trail plan finalized in 2018 with implementation to follow.
<b>Present Actions</b>		
Campground/Rental Maintenance - Hazard Tree removal	11 Campgrounds from Turlo to Beaver Creek campground, and Picnic areas (Hemple, Big 4)	Yearly, on-going - cover in current condition
Mt. Loop Road maintenance	Road cleared, roadside brushed	Yearly, on-going- cover in current condition
Mt. Loop Emergency Road Repair	Road repair and mitigation at select sites along Mt. Loop	Sno.Co. response to high water events in 2015, 2016-2018
Secondary Road maintenance	Routine road maintenance on open roads in the watershed.	On-going, Short-term sediment with maintained ditches.
Trail maintenance	Routine trail maintenance on accessible trails in watershed.	On-going, minor short-term sedimentation.
Invasive Plant Treatments	Treatment of known sites in the watershed.	On-going, minor short-term impacts from herbicides.
Non-Federal Land Timber Harvest:	Harvest below Forest boundary – in-holdings	No known
<b>Past Actions - can be part of the current condition and addressed there</b>		
Waldheim Emergency Road repairs	Road repaired and rock buttress slope	Completed 2011- cover in current condition
River Road repairs	Work accepted in 2013 after monitoring.	Completed 2013. - cover in current condition
Waldheim Slide repair mitigation	Riparian and aquatic habitat restoration	Waldheim and Camp Silverton - completed in 2016
Road, campground and trail maintenance	Numerous sites	cover in current condition
Invasive Plant Treatments	Numerous sites	cover in current condition

Repair of Red Bridge Campground road		cover in current condition
Timber sale activity in Canyon Creek		cover in current condition

## 9. Forest Plan Consistency

All Alternatives would be consistent with the Forest Plan, as amended.

## 10. Public Comment Response

## 11. References and Citations

Al-Chokhachy, R., Black, T.A., Thomas, C., Luce, C.H., Rieman, B., Cissel, R., Carlson, A., Hendrickson, S., Archer, E.K., and Kershner, J.L. 2016. Linkages between unpaved forest roads and streambed sediment: why context matters in directing road restoration. *Restoration Ecology* 24: 589-598.

Allen, Douglas; Dietrich, William; Baker, Peter; Ligon, Frank; Orr, Bruce 2007. Development of a Mechanistically Based, Basin-Scale Stream Temperature Model: Applications to Cumulative Effects Modeling. In: Standiford, Richard B.; Giusti, Gregory A.; Valachovic, Yana; Zielinski, William J.; Furniss, Michael J., technical editors. 2007. Proceedings of the redwood region forest science symposium: What does the future hold? Gen. Tech. Rep. PSW-GTR-194. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; p. 11-24

Allan, J.D., Wipfli, M.S., Caouette, J.P., Prussian, A. and Rodgers, J., 2003. Influence of streamside vegetation on inputs of terrestrial invertebrates to salmonid food webs. *Canadian Journal of Fisheries and Aquatic Sciences*, 60(3), pp.309-320.

Amaranthus, M.P., Rice, R.M., Barr, N.R., and Ziemer, R.R. 1985. Logging and forest roads related to increased debris slides in southwestern Oregon. *Journal of Forestry* 83: 229-233.

Anderson, P.D., Larson, D.J., and Chan, S.S. 2007. Riparian buffer and density management influences on microclimate of young headwater forests of western Oregon. *Forest Science* 53: 254-269.

Anderson, P.D. and Poage, N.J. 2014. The density management and riparian buffer study: A large scale silviculture experiment informing riparian management in the pacific northwest, USA. *Forest Ecology and Management* 90-99.

Bash, J., Berman, C., and Bolton, S. 2001. Effects of Turbidity and Suspended Solids on Salmonids.

Beechie, T.J., Pess, G., Kennard, P., Bilby, R.E., and Bolton, S. 2000. Modeling recovery rates and pathways for woody debris recruitment in Northwestern Washington streams. *North American Journal of Fisheries Management* 436-452.

- Beechie, T.J. and Sibley, T.H. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. *Transactions of the American Fisheries Society* 126: 217-229.
- Benda, L., Andras, K., Miller, D., and Bigelow, P. 2004. Confluence effects in rivers: Interactions of basin scale, network geometry, and disturbance regimes. *Water Resources Research* 40: 1-15.
- Benda, L. and Bigelow, P. 2014. On the patterns and processes of wood in northern California streams. *Geomorphology* 219: 79-97.
- Benda, L.E., Litschert, S.E., Reeves, G., and Pabst, R. 2016. Thinning and in-stream wood recruitment in riparian second growth forests in coastal Oregon and the use of buffers and tree tipping as mitigation. *Journal of Forestry Research* 27: 821-836.
- Beschta, R.L. 1978. Long-Term patterns of sediment production following road construction and logging in the Oregon Coast Range. *Water Resource Research* 14: 1011-1017.
- Bilby, R.E., Sullivan, K., and Duncan, S. 1989. The generation and fate of road-surface sediment in forested watersheds in southwestern Washington. *Forest Science* 35: 453-468.
- Bilby, R.E. and Ward, J.W. 1989. Changes in characteristics and function of woody debris with increasing size of streams in Western Washington. *Transactions of the American Fisheries Society* 118: 368-378.
- Bladon, K.D., Cook, N.A., Light, J.T., and Segura, C. 2016. A catchment-scale assessment of stream temperature response to contemporary forest harvesting in the Oregon Coast Range. *Forest Ecology and Management* 313: 153-164.
- Bloom, A.L. 1998. An assessment of road removal and erosion control treatment effectiveness: A comparison of 1997 storm erosion response between treated and untreated roads in redwood creek basin, northwestern, California. Masters Thesis.
- Bourque C, J. H. Pomeroy. 2001. Effects of forest harvesting on summer stream temperatures in New Brunswick, Canada: an inter-catchment, multiple-year comparison. *Hydrology and Earth System Sciences Discussions, European Geosciences Union*, 5(4), pp.599-614.
- Brosofske K.D, J. Chen, R.J. Naiman, J.F. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in western Washington *Ecological Applications* pp. 1188–1200
- Bragg, D.C. and Kershner, J.L. 2004. Sensitivity of a riparian large woody debris recruitment model to the number of contributing banks and tree fall pattern. *Western Journal of Applied Forestry* 19: 117-122.
- Brazier, J.R. and Brown, G.W., 1973. Buffer strips for stream temperature control. Corvallis, Or. : Forest Research Laboratory, School of Forestry, Oregon State University.

Brown, K.R., McGuire, K.J., Aust, W.M., Hession, W.C., and Dolloff, C.A. 2015. The effect of increasing gravel cover on forest roads for reduced sediment delivery to stream crossings. *Hydrological Processes* 1129-1140.

Brown, K.R., McGuire, K.J., Hession, W.C., and Aust, W.M. 114. Can the water erosion prediction project model be used to estimate best management practice effectiveness from forest roads? *Journal of Forestry* 1.

Caissie, D. 2006. The thermal regime of rivers: a review. *Freshwater Biology* 1389-1406.

Cederholm, C.J. and Salo E.O. 1979. The effects of logging road landslide siltation on the salmon and trout spawning gravels of stequaleho creek and the clearwater river basin, Jefferson County, Washington, 1972-1978.

Chan, S.S., Larson, D.J., Maas-Habner, K.G., Emmingham, W.H., Johnston, S.R., and Mikowski, D.A. 2006. Overstory and understory development in thinned and underplanted oregon coast range douglas fir stands. *Canadian Journal of Fisheries and Aquatic Science* 2696-2711.

Clinton, B.D. 2011. Stream water responses to timber harvest: Riparian buffer width effectiveness. *Forest Ecology and Management* 261: 979-988.

Cole, E. and Newton, M. 2013. Influence of streamside buffers on stream temperature response following clear-cut harvesting in western Oregon. *Canadian Journal of Forest Research* 993-1005.

Cole, L. and Newton, M. 2015. Relationships between radiation and canopy closure estimates in streamside buffers in Western Oregon. *Forest Science* 61: 559-569.

Collins, B.D., Montgomery, D.R., and Haas, A.D. 2002. Historical changes in the distribution and functions of large wood in Puget lowland rivers. *Canadian Journal of Fisheries and Aquatic Science* 66-76.

Collins, S.M., Sparks, J.P., Thomas, S.A., Wheatley, S.A., and Flecker, A.S. 2016. Increased light availability reduces the importance of bacterial carbon in headwater stream food webs. *Ecosystems* 396-410.

Davis, L.J., Reiter, M., and Groom, J.D. 2016. Modelling temperature change downstream of forest harvest using Newton's law of cooling. *Hydrological Processes* 959-971.

Dent, L., Vick, D., Abraham, K., Schoenholtz, S., and Johnson, S. 2008. Summer temperature patterns in headwater streams of the Oregon coast range. *Journal of American Water Resources Association* 44: 803-813.

Dent, L.F. and Walsh, J.B.S. 1997. Effectiveness of riparian management areas and hardwood conversions in maintaining stream temperature. *Oregon Department of Forestry* 1-67.

DeWalle, D.R. 2008. Guidelines for riparian vegetative shade restoration based upon a theoretical shaded-stream model. *Journal of American Water Resources Association* 44: 1373-1387.

DeWalle, D.R. 2010. Modeling stream shade: Riparian buffer height and density as important as buffer width. *Journal of American Water Resources Association* 46: 323-333.

Dubé, K., W. Megahan, and M. McCalmon. 2004. Washington Road Surface Erosion Model. Washington Department of Natural Resources, Olympia, WA.

Flanagan II, S.A. 2004. Woody debris transport through low-order stream channels of northwest california - Implications for road-stream crossing failure. Masters Thesis.

Foltz R.B., K.A. Yanosek, and T.M. Brown. 2008. Sediment concentration and turbidity changes during culvert removals. *Journal of Environmental Management* 87 (3): 329-340.

Fox, M. and Bolton, S., 2007. A regional and geomorphic reference for quantities and volumes of instream wood in unmanaged forested basins of Washington State. *North American Journal of Fisheries Management*, 27(1), pp.342-359.

Groom, J.D., Dent, L., Madsen, L.J., and Fleuret, J. 2011. Response of western Oregon (USA) stream temperatures to contemporary forest management. *Forest Ecology and Management* 1-12.

Groom, J. D., L. Dent, and L. J. Madsen 2011. Stream temperature change detection for state and private forests in the Oregon Coast Range, *Water Resour. Res.*, 47, W01501, doi:10.1029/2009WR009061.

Hafs, A.W., Harrison, L.R., Utz, R.M., and Dunne, T. 2014. Quantifying the role of woody debris in providing bioenergetically favorable habitat for juvenile salmon. *Ecological Modelling* 30-38.

Hagans, D.K., Weaver, W.E., and Madej, M.A. 1986. Long term on-site and off-site effects of logging and erosion in the redwood creek basin, Northern California. Report.

Harr, D.R. and Nichols, R.A. 1993. Stabilizing forest roads to help restore fish habitats: A northwest washington example. *Fisheries* 18: 18-22.

Henley, W.F., Patterson, M.A., Neves, R.J. , and Lemly, D.A. 2000. Effects of sedimentation and turbidity on lotic food webs: A concise review for natural resource managers. *Reviews in Fisheries Science* 8: 125-139.

Hicks, B.J., Hall, J.D., Bisson, P.A., and Sedell, J.R. 1991. Responses of salmonids to habitat changes. *American Fisheries Society Special Publication* 19: 483-518.

Isaak, D.J., Young, M.K., Nagel, D.E., Horan, D.L., and Groce, M.C. 2015. The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century. *Global Change Biology* 2540-2553.

- Jackson, R.C. and Sturm, C.A. 2002. Woody debris and channel morphology in first- and second-order forested channels in Washington's coast range. *Water Resources Research* 38: 1-14.
- Janisch, J.E., Wondzell, S.M., and Ehinger, W.J. 2012. Headwater stream temperature: Interpreting response after logging, with and without riparian buffers, Washington, USA. *Forest Ecology and Management* 302-313.
- Jensen, D.W., Steel, E.A., Fullerton, A.H. , and Pess, G.R. 2009. Impact of fine sediment on egg-to-fry survival of pacific salmon: A meta-analysis of published studies. *Reviews in Fisheries Science* 17: 348-359.
- Kiffney, P.M., Buhle, E.R., Naman, S.M., Pess, G.R., and Klett, R.S. 2014. Linking resource availability and habitat structure to stream organisms: an experimental and observational assessment. *Ecosphere* 5: 1-27.
- Kiffney, P.M., Richardson, J.S., and Bull, J.P. 2004. Establishing light as a causal mechanism structuring stream communities in a response to experimental manipulation of riparian buffer width. *Journal of North American Benthological Society* 23: 542-555.
- Kiffney, P.M., Richardson, J.S., and Bull, J.S. 2003. Responses to periphyton and insects to experimental manipulation of riparian buffer width along forest streams. *Journal of Applied Ecology* 40: 1060-1076.
- Leary, R.F. and Allendorf, F.W. 1997. Notes: genetic confirmation of sympatric bull trout and dolly varden in western washington. *Transactions of the American Fisheries Society* 126: 715-720.
- Leinenbach, P., McFadden, G., and Torgersen, C. Effects of riparian management strategies on stream temperature. Science Review Team Temperature Subgroup 1-22.
- Liquori, M.K. 2006. Post-harvest riparian buffer response: Implications for wood recruitment modeling and buffer design. *Journal of the American Water Resources Association* 42: 177-189.
- MacDonald, L.H. and Coe, D. 2007. Influence of headwater streams on downstream reaches in forested areas. *Forest Science* 53: 148-168.
- MacDonald, R.J., Boon, S., Byrne, J.M., Robinson, M.D., and Rasmussen, J.B. 2014. Potential future climate effects on mountain hydrology, stream temperature, and native salmonid life history. *Canadian Journal of Fisheries and Aquatic Sciences* 189-202.
- Madej, M.A. 2001. Erosion and sediment delivery following removal of forest roads. *Earth Surface Processes and Landforms* 26: 175-190.
- Martin, D.J. and Benda, L.E. 2001. Patterns of instream wood recruitment and transport at the watershed scale. *Transactions of the American Fisheries Society* 130: 940-958.

- McDade, M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. Van Sickle. 1990. Source distances for coarse woody debris entering small streams in western Oregon and Washington. *Can. J. For. Res.* 20: 326-330.
- Meleason, M. A., Gregory, S. V. and Bolte, J. P. 2003. Implications of riparian management strategies on wood in streams of the pacific northwest. *Ecological Applications*, 13: 1212–1221.
- Michel, C., Schmidt-Posthaus, H., and Burkhardt-Holm, P. 2013. Suspended sediment pulse effects in rainbow trout (*Oncorhynchus mykiss*) - relating apical and systemic responses. *Canadian Journal of Fisheries and Aquatic Science* 630-641.
- Miller, D., Luce, C., and Benda, L. 2003. Time, space, and episodicity of physical disturbance in streams. *Forest Ecology and Management* 178: 121-140.
- Montgomery, D.R., Beamer, E.M., Pess, G.R., and Quinn, T.P. 1999. Channel type and salmonid spawning distribution and abundance. *Canadian Journal of Fisheries and Aquatic Science* 377-387.
- Montgomery, D.R. and Buffington, J.M. 1997. Channnel-reach morphology in mountain drainage basins. *GSA Bulletin* 109: 596-611.
- Montgomery, D.R., Buffington, J.M., Smith, R.D., Schmidt, K.M., and Pess, G. 1995. Pool spacing in forest channels. *Water Resources Research* 31: 1097-1105.
- Moore, D.R. and Wondzell, S.M. 2005. Physical hydrology and the effects of forest harvesting in the pacific northwest: A review. *Journal of American Water Resources Association* 41: 763-784.
- Newcombe, C.P. and Jensen, J.O. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. *North American Journal of Fisheries Management* 693-727.
- Newton, M. and Ice, G. 2016. Regulating riparian forests for aquatic productivity in the pacific northwest, USA: addressing a paradox. *Environmental Science and Pollution Research* 1149-1157.
- Pollock, M.M. and Beechie, T.J. 2014. Does riparian forest restoration thinning enhance biodiversity? The ecological importance of dead wood. *Journal of American Water Resources Association* 50: 543-560.
- Pollock, M.M., Beechie, T.J., Liermann, M. , and Bigley, R.E. 2009. Stream temperature relationships to forest harvest in western washington. *Journal of the American Water Resources Association* 45: 141-156.
- Pollock, M.M., Pess, G.R., Beechie, T.J., and Montgomery, D.R. 2004. The importance of beaver ponds to coho salmon production in the Stillaguamish River basin, Washington, USA. *North American Journal of Fisheries Management* 24: 749-760.

Rashin, E.B., Clishe, C.J., Loch, A.T., and Bell, J.M. 2006. Effectiveness of timber harvest practices for controlling sediment related water quality impacts. *Journal of the American Water Resources Association* 42: 1307-1327.

Raymond, C.L., Peterson, D.L. and Rochefort, R.M., 2014. Climate change vulnerability and adaptation in the North Cascades region, Washington. General Technical Report-Pacific Northwest Research Station, USDA Forest Service, (PNW-GTR-892).

Redding, J.M., Schreck, C.B., and Everest, F.H. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. *Transactions of the American Fisheries Society* 116: 737-744.

Reid, S.M. and Anderson, P.G. 1999. Effects of sediment released during open-cut pipeline water crossings. *Canadian Water Resources Journal* 24: 235-251.

Ried, L. M., & Dunne, T. 1984. Sediment production from road surfaces. *Water Resources Research*, 20, 1753-1761.

Rosenfeld, J.S. and Huato, L. 2003. Relationship between large woody debris characteristics and pool formation in small coastal British Columbia streams. *North American Journal of Fisheries Management* 23: 928-938.

Rundio, D.E. and Lindley, S.T., 2008. Seasonal patterns of terrestrial and aquatic prey abundance and use by *Oncorhynchus mykiss* in a California coastal basin with a Mediterranean climate. *Transactions of the American Fisheries Society*, 137(2), pp.467-480.

Shaw, E.A. and Richardson, J.S. 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout (*Oncorhynchus mykiss*) growth and survival. *Canadian Journal of Fisheries and Aquatic Science* 2213-2221.

Shellberg, J.G., Bolton, S.M., and Montgomery, D.R. 2010. Hydrogeomorphic effects on bedload scour in bull char (*Salvelinus confluentus*) spawning habitat, western Washington, USA. *Canadian Journal of Fisheries and Aquatic Sciences* 626-640.

Spies, T., Pollock, M., Reeves, G., and Beechie, T. 2013. Effects of riparian thinning on wood recruitment: A scientific synthesis. Science Review Team Wood Recruitment Subgroup 1-46.

Sridhar, V., Sansone, A.L., LaMarche, J., Dubin, T., and Lettenmaier, D.P. 2004. Prediction of stream temperature in forested watersheds. *Journal of American Water Resources Association* 40: 197-213.

Sternecker, K. and Geist, J. 2010. The effects of stream substratum composition on the emergence of salmonid fry. *Ecology of freshwater fish* 19: 537-544.

Stillaguamish Technical Advisory Group (STAG) 2000. Technical Assessment and Recommendations for Chinook salmon recovery in the Stillaguamish Watershed.

Stillaguamish Implementation Review Committee (SIRC). 2005. Stillaguamish Watershed Chinook Salmon Recovery Plan. Published by Snohomish County Department of Public Works, Surface Water Management Division. Everett, WA.

Studinski, J.M. and Hartman, K.J. 2015. The effects of riparian logging on terrestrial invertebrate inputs into forested headwater streams. *Hydrobiologia* 189-198.

Suren, A.M. and Jowett, I.G. 2001. Effects of deposited sediment on invertebrate drift: An experimental study. *New Zealand Journal of Marine and Freshwater Research* 35: 725-737.

Suttle, K.B., Power, M.E., Levine, J.M., and McNeely, C. 2004. How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. *Ecological Applications* 14: 969-974.

Swanson, F.J. and Dyrness, C.T. 1975. Impact of clear-cutting and road construction on soil erosion by landslides in the western cascade range, Oregon. *Geology* 393-396.

Sweeney, B.W. and Newbold, D.J. 2014. Journal of American Water Resources Association. Streamside forest buffer width needed to protect stream water quality, habitat, and organisms: A literature review. 50: 560-584.

Switalski, T.A., Bissonette, J.A., DeLuca, T.H., Luce, C.H., and Madej, M.A. 2004. Benefits and impacts of road removal. *Frontiers in Ecology* 2: 21-28.

USDA Forest Service. (1990). Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan and Final EIS. Seattle, WA: Mt. Baker-Snoqualmie National Forest.

USDA Forest Service. (1994). Lower South Fork Stillaguamish River and Canyon Creek Watershed Analysis. Everett, Washington: Mt. Baker-Snoqualmie National Forest.

USDA Forest Service. (1995). South Fork Upper Stillaguamish Watershed Analysis. Everett, Washington: Mt. Baker-Snoqualmie National Forest.

USDA Forest Service and USDI Bureau of Land Management. (1994). Record of Decision for Amendments to the Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl. Portland, OR.

USFWS. 1998. A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation (substitute core area ) Watershed Scale. Region 1, Portland, USFWS.

Trombulak, S.C. and Frissell, C.A. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology* 14: 18-30.

Van Sickle, J., and S.V. Gregory. 1990. Modeling inputs of large woody debris to streams from falling trees. *Can. J. For. Res.* 20: 1593-1601.

- Warren, D.R., Collins, S.M., Purvis, E.M., Kaylor, M.J., and Bechtold, H.A. 2016. Spatial variability in light yields colimitation of primary production by both light and nutrients in a forested stream ecosystem. *Ecosystems* doi:10.1007/s10021-016-0024-9.
- Warren, D.R., Keeton, W.S., Bechtold, H.A. , and Rosi-Marshall, E.J. 2013. Comparing streambed light availability and canopy cover in streams with old growth versus early-mature riparian forests in western Oregon. *Aquatic Sciences* 547-558.
- Washington Department of Ecology. 2004. Stillaguamish River Watershed Temperature Total Maximum Daily Load Study. Publication # 04-03-010
- Washington Department of Ecology. 2006. Stillaguamish River Watershed Temperature Total Maximum Daily Load: Water Quality Improvement Report -- Vol. 2: Implementation Strategy. Publication # 06-10-057
- Washington Department of Fish and Wildlife. 2002. Washington State Salmon and Steelhead Stock Inventory. Olympia, WA. Online update to WDF et al. 1993.
- Washington Department of Fish and Wildlife. 2012. Memorandum of Understanding between the Washington State Department of Fish and Wildlife and the USDA Forest Service Pacific Northwest Region. MOU Number: NFS 12-MU-11062754-005.
- Washington Department of Fish and Wildlife. 2016. Incorporating Climate Change into the Design of Water Crossing Structures. Olympia, WA
- Wemple, B.C., Swanson, F.J., and Jones, J.J. 2001. Forest roads and geomorphic process interactions, cascade range, Oregon. *Earch Surface Processes and Landforms* 26: 191-204.
- Wenger, S.J., Isaak, D.J., Dunham, J.B., Fausch, K.D., Luce, C.H., Neville, H.M., Rieman, B.E., Young, M.K., Nagel, D.E., Horan, D.L. and Chandler, G.L., 2011. Role of climate and invasive species in structuring trout distributions in the interior Columbia River Basin, USA. *Canadian Journal of Fisheries and Aquatic Sciences*, 68(6), pp.988-1008.
- Wilkerson, E., Hagan, J.M., Siegel, D., and Whitman, A.A. 2006. The effectiveness of different buffer widths for protecting headwater stream temperature in Maine. *Forest Science* 52: 221-231.
- Zwieniecki, M.A. and Newton, M. 1997. Influence of streamside cover and stream features on temperature trends in forested streams of Western Oregon. *Western Journal of Applied Forestry* 14: 106-113.

## **12. Maps (Indexed) if not within report**

---

end